REPORT OF

NATIONAL TASK FORCE ON GEOSPATIAL EDUCATION

MINISTRY OF HUMAN RESOURCE DEVELOPMENT

Government of India
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Volume I

REPORT OF

NATIONAL TASK FORCE ON GEOSPATIAL EDUCATION

Contents of Volume I

List of Abbreviations (Volume I & II)

AICTE	All India Council of Technical Education
BISAG	Bhaskaracharya Institute of Space Applications and Geomatics
BITS	Birla Institute of Technology and Science
CBSE	Central Board Of Secondary Education
DCE	Delhi College of Engineering
DRDO	Defence Research & Development Organization
DST	Department of Science and Technology
EDUSAT	Educational Satellite
ESRI	Environmental System Research Institute
GI	Geographical Indications
GIS	Geographical Information System
GKR	Geospatial Knowledge Repository
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GTOP	Geospatial Training and Outreach Project
GUNP	Geospatial University Networking Project
IGNFA	Indira Gandhi National Forest Academy
IIM	Indian Institute of Management
IIRS	Indian Institute of Remote Sensing
IISM	Indian Institute of Surveying and Mapping
IIT	Indian Institute of Technology
IMRB	Indian Market Research Bureau
INGO	International Non Governmental Organization
IOCL	Indian Oil Corporation Limited
ISRO	Indian Space Research Organization
ITI	Industrial Training Institute
ITRF	International Terrestrial Reference System
JNNURM	Jawaharlal Nehru National Urban Renewal Mission

LBSNAA	Lal Bahadur Shastri National Academy of Administration
LiDAR	Light Detection and Ranging
MHRD	Ministry of Human Resource Development
MNREGA	Mahatma National Rural Employment Guarantee Act
MOES	Ministry of Earth Science
MST	Ministry of Science and Technology
NATMO	National Atlas and Thematic Mapping Organization
NCERT	National Council of Educational Research and Training
NGKEM	National Geospatial Knowledge, Engineering and Management
NHM	National Health Mission
NIGKEM	National Institute of Geospatial Knowledge, Engineering and Management
NIIT-GIS	National Institute of Information Technology-Geographic Information System
NIT	National Institute of Technology
NITHE	National Institute for Training of Highway Engineers
NLRMP	National Land Record Modernization Program
NPTI	National Power Training Institute
NRDMS	National Resource Data Management System
NRSC	National Remote Sensing Centre
NSDI	National Spatial Data Infrastructure
ONGC	Oil and Natural Gas Corporation
PC	Personal Computer
QA/QC	Quality Assurance/Quality Control
RDBMS	Relational Database Management System
RRSSC	Regional Remote Sensing Service Centre
RS	Remote Sensing
SAC	Space Application Centre
SGEP	School Geospatial Education Project
SOI	Survey of India
UGC	University Grants Commission

Executive Summary of Report on Geospatial Education

1. The XII Five Year Plan has a vision for rapid, sustainable and more inclusive growth. It emphasizes the need to put in place effective policies, particularly in infrastructure, energy, rural development, management of cities and governance, to give a fillip to growth. To achieve the ambitious targets included in XII Five Year Plan and beyond, it is pertinent to embrace information and communication technology, particularly geospatial technology for planning, implementing and monitoring of projects of national importance. Hence, Geospatial Education will be a crucial area for developing the human resources required for this purpose as also for utilising the employment and self-employment opportunities for skilled manpower in this emerging and inter-disciplinary field of study.

2. Realizing the importance of Geospatial Education, MHRD constituted the National Task Force on Geospatial Education which discussed the overall issues relating to geospatial education in the country at school level, university level, training and outreach needs, need for high-end research and also the possibility of setting up of an institution for geospatial education.

3. Geospatial technology encompasses the practices related to developing, managing, interpreting or analysing geographically referenced data and includes everything that is 'spatial' in its characteristic and content. Geospatial information empowers the nation to understand its topography, natural resources and human capital and allows it to develop the requisite industrial policies to harness its resources. Worldwide today, geospatial technology is finding application in almost every economic activity and is enhancing the productivity and efficiency of major industries including mining and exploration, infrastructure, transportation, energy,

telecommunications and agriculture. The effective use of geospatial information in development projects can cut costs, improve efficiencies, speed-up projects and increase productivity. In India, geospatial information is of great significance in rural development, urban development, infrastructure and energy. In addition to these, geospatial technologies can help/facilitate proper implementation of social sector schemes.

4. Today, the global geospatial industry worldwide is around 40 billion USD as against an anticipated USD of 5 billion a decade ago. The Indian geospatial industry consists of two distinct but mutually supporting segments.

    i.   The domestic segment, which provides geospatial capabilities to the Indian data providers/users. This segment is funded, managed and controlled largely by the national and state governments. A number of Indian firms are contracted to provide services for government initiatives.

    ii. The international segment is geared to provide geospatial data and software development services for international organisations, primarily in North America and Western Europe.

5. The Indian geospatial industry growth rate is significantly higher than worldwide geospatial industry growth owing to the fact that India's macroeconomic parameters are fragile and volatile but nevertheless positive. Another significant factor contributing to the growth of geospatial industry is that the Government of India has budgeted a wide range of initiatives that have a significant geospatial component. These initiatives, along with state and local level initiatives, have the potential to motivate a much stronger internal capacity for geospatial technology in India.

6. The current plans and initiatives of Government of India call for geospatial capabilities that are larger than what the geospatial industry can currently provide. The government and the geospatial industry will have to consider ways/means to improve the educational system for geospatial workers at skilled and semi-skilled

levels. The Task Force on Geospatial Education felt that there are major gaps which need to be bridged in the geospatial knowledge arena. Based on the depth of knowledge required, type of knowledge imparted and intended professional level of the students, geospatial professionals are required at three levels.

- **Geospatial skilled workforce –** a category of large number of human resources required to form the "pyramid-base" and who will be the large work-force for survey/mapping/GIS operators etc.

- **Technical Geospatial Professionals** – are a large number of geospatial professionals who have specific training and knowledge for specific tasks – these form the "pyramid middle". These are graduates with a specific 9-12 months training in geospatial technology (GPS Surveying; Data Capture from Images; Geodatabase creation; QA/QC processes and so on).

- **Geospatial experts** who have a graduate/masters degree in geospatial technology form the "pyramid top" of the workforce. These would be the project managers who are capable of handling geospatial projects independently.

The following are the major recommendations:

1. Four projects are recommended:

   - School Geospatial Education Project (SGEP) – led by the Department of School Education, MHRD;

   - Geospatial University Networking Project (GUNP) – led by the Department of Higher Education, MHRD;

   - Geospatial Training and Outreach Project (GTOP) – led by DST; and

   - National Institute of Geospatial Knowledge, Engineering and Management (NIGKEM), NIGKEM project – led by MHRD and DST.

2. A number of reform actions, namely, CBSE and NCERT to include geospatial technology in middle and high-school curricula, coordination with state school boards for a similar inclusion, School teachers' orientation for geospatial technologies, develop prototypes of school geospatial kits, encouraging

Universities to standardise curricula and undertake faculty orientation , wide usage of low-cost, public-domain software and hardware resources, Industries to come out with such education products that can be used at university levels, Geospatial technology and applications to form a part of civil-services academies and re-orientation programmes, coordination with Central Ministries to ensure that training pools are dedicated to train government employees.

3. Other strategies are Self-Learning and Igniting Approach at School Level, Geospatial Research and Education Capacity at University Level and Training and Outreach for Enabling Geospatial Capability Amongst Existing Professionals.

4. A high-level management council is also recommended with Minister, MHRD as Chair and Member (Science), Planning Commission as Co-Chair, with various Secretaries as Members and experts as Members, for guiding and supervising the implementation of recommendations.

1. INTRODUCTION

1.   **National Task Force on Geospatial Education** was established by the Ministry of Human Resources Development (MHRD) vide Notification No. 17-21/2010/ Policy Norms-I, dated October 15, 2010. The office order of the Task Force is given in ANNEXURE-I.

2.   The Task Force met three times and finalised this report. The Task Force considered a background note (ANNEXURE-II) in its first meeting and discussed the overall issues related to geospatial education in the country at school level, university level, training and outreach needs, need for high-end research and also the possibility of setting up an institution for geospatial education. Based on the discussion, the Task Force established 4 sub-groups to address specific issues related to geospatial education as follows:

- Sub-Group on Geospatial Education at School level
- Sub-Group on Geospatial Education at University level
- Sub-Group on Geospatial Awareness, Training and Outreach
- Sub-Group on Indian Institute of Geospatial Technology

3.   The sub-groups met at their own level and submitted their respective reports that are reproduced in Volume-II of this Task Force Report titled, *"Report of Sub-Committees of Task Force on Geospatial Education"*.

4.   The Chairman requested four members (Mr Amit Khare; Dr Mukund Rao; Dr R Sivakumar and Mr Sanjay Kumar) to study all the 4 sub-group reports and integrate them into the final framework of the Task Force Report. They were asked to integrate all recommendations and define an implementation strategy.

5.   This report (Volume – I of Task Force Report) outlines the integrated recommendations and also gives a strategic approach to geospatial education at

school and university level; training and outreach needs and also proposes the National Institute for Geospatial Knowledge Engineering and Management (NIGKEM). Volume-II of the report may be read in conjunction with this volume.

2. BACKGROUND

6. India has a population of about 1.2 billion, out of which more than 700 million are in the age-group 15-59 years, who form the 'working age population'. This group of population is an invaluable asset for the country, which, if equipped with the right knowledge and skills, can contribute significantly to the growth of the nation as well as the world.

7. The Union Ministry of Human Resources Development (through the Department of Higher Education) works towards developing India as a knowledge society. MHRD's constant endeavour is to improve and expand education in all sectors, with a view to eliminate disparities in access while laying greater emphasis on the improvement in the quality and relevance of education at all levels.

8. The 12th Five Year Plan lays emphasis on 'Improved Access to Quality Education' and improving the utility of education, while ensuring equity and affordability in all disciplines that contribute to the nation's development. Amongst the various technologies that government considers during the 12th Plan period, geospatial technology is key to many aspects of governance and commerce.

3. GEOSPATIAL TECHNOLOGY — SIGNIFICANCE & APPLICATIONS

9. Geospatial technology encompasses technologies related to creating, managing, analysing and using geographically referenced data and includes everything that is 'spatial' in its characteristic and content. It includes a wide variety of hardware,

software, data and application solutions and services. Geospatial technology enables spatial and non-spatial data to be brought together from multiple sources, process and analyse so that various types of development and 'what-if' scenarios can be obtained enabling better correlative analysis for effective decision-making. Geospatial technology is the most potent toolset for decision- makers, government, industry and citizens alike.

10. The diversity of geospatial technology today is so wide that its over-arching ambit covers principles and fundamentals drawn from many disciplines, including geographical sciences, mapping and cartography, geodesy, satellite- based remote sensing, aerial photogrammetry, image processing, GNSS, LiDAR, geospatial visualisation and modelling techniques. All of these areas need to be furthered as an integrated technology discipline.

11. Geospatial technology touches almost all areas of life and living, including agriculture, environment, governance, defence and homeland security, infrastructure and utilities and enterprise management. From scales of economies too, geospatial has tremendous potential and many nations are implementing large national geospatial projects.

12. India is growing at a fast pace and has ambitious development plans. To achieve its growth targets, India has to equip itself with this important technology and be part of a regime where geospatial technology capability will determine its success and leadership in the comity of nations. The government of India has mandated the use of geospatial technology for several national development projects under the 12th Five Year Plan.

13. As geospatial technology encompasses diverse aspects, the Task Force recommends that the Geospatial Education Strategy's over-arching ambit must cover principles and fundamentals drawn from many disciplines including geographic sciences;

surveying; mapping and cartography; geospatial databases; geospatial applications; geospatial policy and legal regimes.

4. NATIONAL GIS AND CAPACITY BUILDING

14.   In 2011, Planning Commission, Government of India constituted an expert group — Interim Core Group chaired by Dr. Shailesh Nayak, Secretary, MoES to define the vision and programmatic details of National GIS. Presently, the National GIS is under process of approval through the Department of Science and Technology, Government of India.

15.   The National Vision and Programme Document and as available on the web-site of Ministry of Earth Sciences at (http://www.moes.gov.in/national_gis.pdf) (IG, 2011). The National GIS Vision encompasses the Draft Report on Geospatial Education Task Force and included key aspects of capacity building into the National GIS Vision. As part of the National GIS efforts, it is important to address the above strategy for creating the knowledge base of GIS in the country.

16.   The National GIS document states that while MHRD can initiate its own GIS education and research programmes for schools and universities, these would bring significant impact over few years with GIS knowledge embedded in the future generation. However, there is an urgent need to address the present large number of professionals and decision-makers from government and private sector with basic knowledge of National GIS so that they are tuned and oriented for using GIS process flows in their decision and work-processes. This must be addressed by INGO. It is important to position such national interventions for a knowledge innovation programme and "boosting" present education/research and training mechanisms in GIS.

5. KEY ISSUES OF GEOSPATIAL EDUCATION

5.1   Present scenario of geospatial knowledge management

17.   At present, geospatial education and knowledge dissemination in India is through the existing university and education systems that provide the capacity-building and HR development activities. Some important highlights of the existing geospatial education in India include:

a. Few universities (like Anna University, Chennai; Bharatidasan University, Tiruchirapalli; Symbiosis Institute of Geo-informatics, Pune; Jawaharlal Nehru Technological University, Hyderabad; Andhra University, Vishakhapatnam; Kumaun University, Almora etc that offer graduate and post-graduate courses in GIS and RS). These institutions bring out about 200-300 professionals in geospatial technology every year.

b. Specialised institutions (like Indian Institute of Remote Sensing, Dehradun; Indian Institute of Survey and Mapping of Survey of India, Hyderabad; Bhaskaracharya Institute of Space Applications and Geomatics (BISAG), Gandhinagar and so on) offer specialised training and orientation programmes. These cater to in-service and on-job training on RS and GIS in specialised fields as well.

18.   From a technological point of view, the Task Force feels there are major gaps that need to be bridged in the geospatial knowledge arena. The table below shows an assessment of knowledge/skill-gaps in various geospatial activities:

Geospatial Technology	Leadership	Managerial skill	Technical Skills	Consulting and Systems Analysis	Research/ Modelling
Geographic Science	Low	Low	Low	Low	Low
Survey/Mapping	Low	Average	Very Good (but limited)	Average	Low
Geospatial database development	Low	Very Good	Very Good	Average	Average
GIS Applications & S/w development	Low	Average	Average	Average	Average
Solution architecturing / deployment	Average	Average	Good	Average	Low

19. Geospatial technology is changing at a rapid pace and many institutions in the country face tremendous challenges in keeping pace with the technology advances. Universities lack funds and are unable to update facilities and get modern tools and systems (hardware and software) and thus knowledge remains in old regimes and does not get enhanced with time.

20. These aspects impact the quality of education and knowledge generated and so restricts the capacities to the lower-end, labour-intensive activities – say, surveying and mapping. This is not a good scenario as it makes India a "labour-force" as against a "knowledge force" in geospatial technology.

21. The Task Force noted a DST Committee Report (Prithvish Nag Committee, 2010) that had strongly recommended in favour of enabling the existing universities; need for a standardised curriculum design for diploma, bachelors and post-graduate courses in all universities; constant training of teachers to update their knowledge; urgent need for infrastructure improvement in these universities etc. as key aspects.

5.2 Increasing demand for geospatial professionals

22. At the global level, geospatial industry is estimated to be about USD ~4-5 billion (2010). Even in India (GIS Development, 2010), during the 11th Plan period, the government sector has allocated/spent almost INR 5000–6000 crore on projects/ activities which depend on/use geospatial technology.

23. The current and future government projects of national importance, private sector projects to provide services and the citizens' needs of specific geospatial information would require a strong knowledge-base and a skilled work-force than are available or will be trained by the current education system.

24. The Task Force determined that geospatial professionals are required in the country at three levels – based on the depth of knowledge required; type of knowledge imparted and intended professional level of the students:

- Geospatial skilled workforce – a category of large number of human resources required to form the "pyramid-base" and who will be the large work-force for survey/mapping/GIS operators *etc.* This requirement can be met through special training programmes in ITIs, polytechnics, technical institutions and the private industry.

- Technical Geospatial Professionals – are a large number of geospatial professionals who have specific training and knowledge for specific tasks – these form the "pyramid middle". These are graduates with a specific 9-12 months' training in geospatial technology (GPS Surveying; Data Capture from Images; Geodatabase creation; QA/QC processes and so on). This requirement can be met through specialised training courses by private industry and technical institutions in the country, like IIRS and IISM.

- A good number of geospatial experts, with a graduate/masters degree in geospatial technology, form the "pyramid top" of the workforce. These would be the project managers who are capable of handling geospatial projects independently. These are basically B.Tech/M.Tech in Geomatics/GI Science *etc.* from the existing universities.

25. Various studies have been conducted to estimate the requirement of human resources in the coming years (Ref: (1) GIS Development Report of 2010 (2) IMRB Report of Geospatial Today of 2010). These studies have estimated varying numbers of resource requirements (ranging from an additional requirement of 20,000 to 70,000 over the next 5 years) – these have been studied by the Task Force in-depth. However, the Task Force could not base its recommendations on

the basis of these reports but drew its conclusions on the concept of the diversity of skills required in the geospatial activity. The table below is based on the analysis made by the Task Force and is more a collective estimate of the skill-types required. The following table shows the geospatial resource requirements for the Indian geospatial activity in the next five years:

Geospatial Activity	Survey/ Mapping/ Trained skill-workforce	Trained work-force for Survey/ Mapping, Geo-database and GIS Apps	Educated profession-als for Survey/ Mapping, Geo-database and GIS Apps	Trained users development who would be users	School-level awareness
Present Availability Estimate	~15000-20,000	~6000-10000	~800-1200	~25000-50000	NA
Estimated Additional need by end of 2015	~20000 @4000 -5000 per year	~15000 @~2000-3000 per year	~5000-8000 @ ~1000-1500 per year	~500,000 @ ~50-100K per year	Estimated in phased manner thru NCERT/ State School Boards
Knowledge/ Skill-interventions required	Industrial Train-ing in specific Geospatial Op-erations (2-4 weeks)	In-depth special-ised training in operations/ man-aging (3-12 months)	4-Year Graduate/ 2-Post-Graduate/PhD in Geospatial Tech-nology through Uni-versity	User Training on specific GIS applications operations (1-2 week orienta-tion)	Basic chapters in 9-12 science curriculum; Ad-ditional GIS Kit knowledge exer-cises
Minimum Qualification for knowl-edge/ skill interventions	10th OR 12th Grade school	Graduate in Sci-ence/Arts Or Di-ploma in Comp Apps	12th Grade leading to B Tech/ B Tech lead-ing to M Tech/PhD	Basically a Geospatial technology user in Central/ State govern-ments	School at 6-8 AND 9-12 Grade
Knowledge Credits	Professional Certificate	PG Diploma	B Tech OR M Tech OR PhD	Applied Certifi-cates	Proficiency Certificate

5.3   Need for strengthening geospatial research

26.   There is severe lack of high-quality research in geospatial technology and applications. This, in fact, is causing a limitation in building the knowledge base in geospatial education. The Task Force felt that there are many fundamental, technological and applied research areas which require adequate research to be carried out. These include satellite and airborne remote sensing, geodesy and developing gravity model for India, cartography and mapping, photogrammetry mapping, developing an Indian terrestrial reference frame within the framework of the ITRF and the transformation model between Indian reference system and ITRF, GIS, GPS, electronic surveying, laser scanning, image processing, and data structures.

27.   To supplement the geospatial research activities happening in the country, DST constituted six Geospatial Chairs in various institutions across the country. A fixed fund and two junior research fellows (JRFs) are attached to each Chair. These Chairs are - McKenzie Chair-Anna University, Chennai; Dr K L Rao Chair-University of Hyderabad; Sir Arthur Cotton Chair-Andhra University, Visakhapatnam; Mokshagundam Visvesvaraya Chair-IISC, Bangalore; Srinivasa Ramanujan Chair- Dr Babasaheb Ambedkar University, Aurangabad and Raja Todarmal Chair-University of Calcutta, Kolkata.

5.4   University networking and capacity building

28.   The Task Force feels that the direction of geospatial education would be determined more by the market needs and also the ability of the Indian system to offer good and growth-oriented career opportunities. This is the principle on which universities and institutions would offer education rather than a "state sponsored" approach. On the other hand, MHRD must make efforts to encourage universities to strengthen their capabilities and offer high-quality courses in tune with the market

needs. MHRD could even consider encouraging private sector universities to offer geospatial courses and prepare for the next generation of students.

29.   The Task Force feels that there are already various universities/institutions (in public and private sector) offering various geospatial education courses and thus ADDING another education-oriented institute may not be the appropriate solution. Rather, the existing institutions must be strengthened to perform their goals of furthering geospatial education and also linking them to industry to create greater career opportunities.

5.5   Geography in school education: Issues

30.   The Task Force has noted that NCERT and the State Boards address geospatial topics in science and geography curriculum at high-school level. CBSE is running a pilot project with geospatial as a vocational subject/elective subject in Class XI. While just four CBSE affiliated schools registered for the course in 2010, it is expected this would rise if right efforts are made and supported by MHRD.

31.   However, the Task Force feels that a lot more needs to be done, especially in school-level non-formal teaching and building school- level capabilities. The Task Force has noted that:

i.   There is a complete lack of understanding of "spatial context". The ability to read maps, recognise map objects, create maps, concepts of terrain, 3D visualisation and the understanding of the utility of geospatial concepts should increase substantially at secondary and high school levels.

ii.   One the biggest impediments in the teaching of geospatial concepts is the availability of trained and motivated teachers who can spark interest in students and make the subject interesting.

iii. Even traditional subjects like history, science, environment, social science etc. have great relevance to maps and geospatial data and could also include graphical or map -based methods. This requires proper orientation of teachers towards the concepts.

iv.   Many schools, even in urban India, lack basic facilities like a PC with a projection system and access to the internet. As a result, most students are not

exposed to free online resources like Bhuvan and Google Earth to better understand the concept of spatial context.

32.   The Task Force notes that school level education must be given boost – especially for 6-8 grades and 9-12 grades in as many schools as possible. This would be possible by organising concerted orientation programmes for teachers; making school-kits available; and encouraging schools to introduce geospatial subjects. The Task Force feels that CBSE and others must be involved majorly in this activity.

6. GEOSPATIAL EDUCATION AND TRAINING – STRATEGIC APPROACH

33.   The Task Force envisages that geospatial technology and applications will have greater and greater relevance in nation-building and also in the world – where possessing high-value knowledge in geospatial arena will distinguish India in the fore-front of nations. The Task Force thus opines that India should embark on building its internal capacities vis-à-vis geospatial technology.

34.   The Task Force recommends a ***four-pronged approach*** for geospatial education – at school-level to 'ignite the first spark'; at university level to build 'knowledge capacity'; training and outreach to 'make professionals up-to-date'; and creating a knowledge culture for geospatial technology and applications through an institutional mechanism.

6.1   Geospatial education at school level – Igniting the geospatial spark

35.   The endeavour of early education is to stimulate the cognitive development of a child in a holistic manner and spatial cognition is one essential aspect of it. To enable this, India needs concerted programmes and concrete action to 'ignite the geospatial spark' in young minds at school level.

36. The Task Force appointed a sub-group to address the issues related to geospatial education at school level. The following members and special invitees participated in the sub-group:

- Mr Kaushik Chakraborty, MD, Erdas India
- Dr Hrishikesh Samant, Sr. Associate Editor, GIS Development
- Mr Vineet Joshi, Chairman, Central Board of Secondary Education
- Mrs Arunima Suresh, AEO, Central Board of Secondary Education

37. The detailed report of the sub-group is given in the Volume-II of the Task Force Report. Based on the recommendations of the sub-group, the Task Force recognises that a concerted effort is required to invest in school-level education. The Task Force recommends that MHRD develop a 'Bharat-Gyan' programme targeted at schools and support schools.

38. The Task Force's strategy to 'ignite the geospatial spark' in young minds at school level is by way of:

- Incentivising geospatial teaching in schools by involving and orienting teachers and linking subjects like environment, geography, history etc. and creating a 'know your surroundings' or 'Bharat Gyan' programme for students belonging to 6-9 and 9-12 grades. Special school-level projects like 'Mapping the Neighbourhood' can be institutionalised at school-level to create strong awareness and ignite participative spirit amongst the students. These programmes could introduce the fundamental spatial concepts, the ability to read a map, concept of terrain and 3D, basic use of GPS & location- based services, use of satellite images, making maps and the applications of multiple layers of maps usage.

- Teacher's training is an important component and a concerted drive for training and orienting teachers need to be called for. These could be tailored as special holiday-workshops or specialised off-line teaching aids.

- Productionising the school geospatial kit: MHRD interventions, through CBSE and NCERT, must result in the production of school geospatial education kits – containing ready-to-use images, maps, exercise books, tutorials, software, small hardware like basic GPS units, internet modems, result templates etc that can be easily used by teachers and students under the Bharat-Gyan programme. Such kits can be designed by professional agencies and institutes – which can then be productionised by industry for MHRD. A very good example of this is "Learning to Think Spatially" at http://www.nap.edu/catalog.php?record_id=11019

39. MHRD must involve CBSE and other similar institutions to roll out such a programme. MHRD can also involve private sector to produce and market the kits to a large number of schools and reach out in multiple languages and geographies.

6.2 University level geospatial education – Building knowledge capacity

40. The Task Force noted that there are quite a few universities that are offering geospatial education leading to MS, B.Tech/BE, M.Tech and PhD programmes. However, many of these institutions lack modern facilities and have no capability to modernise and upgrade periodically, lack teaching faculty that is up-to-date. Many a times, students passing out from these universities join in the lower-end of career chain and do not contribute to the knowledge base. This needs urgent attention and reversal.

41. The Task Force appointed a sub-group to address the issues related to geospatial education at university level. The following members and special invitees attended the meeting:

- Prof. S S Mantha, Chairman, AICTE
- Ms. N A Kazmi, Secretary, UGC
- Prof. P K Garg, IIT Roorkee
- Dr. Bharat Lohani, IIT Kanpur
- Dr. S G Bhirud, AICTE
- Dr. R M Kumar, UGC

42. The sub-group has studied geospatial education in the following institutions:

IITs, IIMs, NITs, BITS, DCE and other equivalent institutes

Technical universities and colleges at central and state level

Central and state universities and colleges run by these

43. The report of the sub-group is given in Volume-II of the Task Force report. The Task Force envisages that the future of Indian geospatial technology education will be secure only if universities are able to produce highly knowledgeable scholars/ students which will, in turn, provide the much needed geospatial backbone to the government and industry.

44. The Task Force recommends a networking approach for bringing all universities/ institutions under the 'knowledge umbrella' by way of:

- Job-oriented skill training (2-4 weeks on special topics): This is best done by private industry as part of on-job training. However, certain ITIs, polytechnics in the country can be enabled to undertake this skill-training in specialised areas that will serve such needs of the government.

- Professional Training (6-12 months geospatial training): This is best done by existing institutions – IIRS, IISM and other agencies. ITIs, polytechnics can be enabled to take this training in special areas for government needs. Private industry – especially private universities can be encouraged to undertake this sort of training needs.

- University education (B. Tech/ M. Tech/ PhD): The following recommendations are made:

  i. The Task Force recommends that the capacity in the country must reach a level to produce ~500 B. Tech students, ~200 M. Tech students and ~100 PhD students per year. While IITs, NITs can start such courses, support to private engineering colleges should be encouraged to start these programmes. Institutes running these programmes would require special one-time government support to establish state-of-the-art geospatial laboratory facilities and to attract excellent faculty.

  ii. Existing universities must be strengthened – a special one-time grant could be made by MHRD to each such university so that they can establish a department to take up high-quality geospatial education. IITs, NITs must be encouraged to have such courses. Private universities must be encouraged to establish geospatial departments and even a time-bound project funding for this can be considered by MHRD.

  iii. Standardisation of curriculum and continuous review and updating – not just at B Tech/ M Tech courses but also in BSc courses. These activities can be initiated by UGC, AICTE and other mechanisms that already exist.

  iv. Through NIGKEM, enable a network of universities that can standardise and update curriculum, facilities, access to NIGKEM resources *etc.*

  v. A continuous opportunity for enhancing the capabilities of the faculty– at a few selected universities and also through NIGKEM.

  vi. Enable a common facility that is state-of-the-art so that universities could "soft lease" this facility.

  vii. Provide a platform for its students to benefit from high-quality research opportunities.

45. NIGKEM must be involved in developing this activity and network all universities under a standardised curricula/faculty/facility/research knowledge base.

6.3 Maximising geospatial awareness, training and outreach

46. The Task Force noted that there are a large number of professionals in the government sector (both centre and states), private sector and even citizens who need to have customised and relevant training to become geospatially literate so that they can adapt and use geospatial technology solutions within their own work-practices. As the numbers are large, the depth of training and outreach could be less and more broad-based to make the professionals comfortable in using and practising geospatial solutions in their work.

47. The Task Force appointed a sub-group to assess the status and need for geospatial awareness, training and outreach and recommend future steps for strengthening this activity. The following members and special invitees attended the meeting:

- Prof. P. S. Roy, Director, IIRS
- Mr. Rajesh Mathur, Vice-Chairman, NIIT-GIS
- Dr T. P. Singh, Director, BISAG

48. Geospatial training mainly addresses the three skill needs – one, of user group training for central/state government employees (mainly 1-4 weeks' user training in various aspects); second, for trained workforce who have post-graduate degrees in survey/mapping, geo-database and GIS apps (where 3-12 months post-graduate skill development is required) and third, for survey/ mapping/GIS trained workforce.

49. Such training and outreach programmes are best done through existing institutes like ITIs, training institutions like IIRS, IISM, BISAG, GSI Training Institute and private universities.

50. The Task Force recommends the following:

- At least 100-150 institutions would be required to cater to the three skill-need training programmes. MHRD must encourage ITIs, existing institutions (IIRS,

IISM, GSI-TI, BISAG and others) and even private institutions to take up such programmes. A concerted approach may be required for this purpose.

- User training is best done by involving government programmes/ministries wherein training budget could be pooled to support specialised and customised training for user groups. Programme funds of different ministries/state government (like, funds of JNNURM for urban; MNREGA for rural; NHM for health; NLRMP for land records and so on); Introduce geospatial training in institutes attached to various ministries like NPTI (Power), NITHE (Roads & Highways). It would also be essential to include geospatial technology and applications in the course curriculum of institutes attended by serving officers for induction and refresher training like LBSNA, IGNFA etc.

- This programme must aim to train at least 500,000 users (at different levels – operators, users, middle-level managers, senior officers, decision-makers and even elected representatives) over the next five years.

- Training for trainers (TOT) is a key element in professional training as this can enhance the capacity of teachers/trainers in both industry and academia. Suitable programmes to enhance knowledge of trainers would be essential.

- In all these activities, NIGKEM must be involved to provide the curricula/faculty/ technology knowledge base.

6.4 National Institute for Geospatial Knowledge Engineering/Management – A knowledge-centric approach

51. The Task Force established a sub-group with the following members:

- Mr Amit Khare, JS, Department of HE, MHRD
- Dr R. Sivakumar, CEO, NSDI, DST
- Mr Sanjay Kumar, CEO, Geospatial Media & Communications Pvt. Ltd
- Dr Mukund Rao, GIS Consultant

52. The sub-group met several times and discussed the overall scenario of geospatial technology education in the country. It has decided to take a broader and incisive view of geospatial as a knowledge element that is becoming a critical element. The sub-group consulted a broad range of experts from India and Abroad.

53. While the detailed report of the sub-group is given in Volume-II, the Task Force proposes that India establish a *National Institute for Geospatial Knowledge Engineering/ Management (NIGKEM).*

6.4.1 Vision of NIGKEM

54. The vision of the National Institute for Geospatial Knowledge Engineering and Management (NIGKEM) is to build and develop a national knowledge capability that is founded on technological excellence, innovation and applications – to enhance the geospatial capability of the country. The Institute must incubate, develop and promote excellence and innovation in geospatial research, education, training and overall national capability in geospatial technology.

55. NIGKEM must coordinate capacity-building activities with INGO and enable the development of National GIS.

6.4.2 Goals and objectives

56. The goals and objectives could be:

- **To create a national geospatial excellence and knowledge base through advanced and front-ranking research and technology assimilation programmes:** NIGKEM will undertake funded-research and advanced studies in geospatial technology/applications.
- **Establish a Geospatial Knowledge Network in GIS:** NIGKEM will provide cohesive and single-point knowledge leadership and expertise to academia – schools/colleges/universities, industries – consultancy/practice-definitions, government – research inputs/application assessments/standards and practices and help create a national knowledge base.
- **Plan and Promote Geospatial Education:** NIGKEM will promote geospatial education in schools, colleges and universities, thus furthering formal, non-formal and continuing education systems in geospatial technology.
- **Building National Skills and Competencies in Geospatial technology:** NIGKEM will promote and encourage competency and skill development in geospatial technology in the country by creating, providing, demonstrating and partnering with universities/schools by making accessible and available a basic competency base – consisting of expert faculty, best of GIS facilities, advanced inputs and networked user projects for practical skill development.
- **Develop/Establish, Maintain and make Accessible state-of-the-art Resources on GIS:** NIGKEM will establish, maintain and expand access to exemplary research, educational and practical knowledge resource for students/ faculty/institutions etc through a geospatial knowledge repository (GKR) and
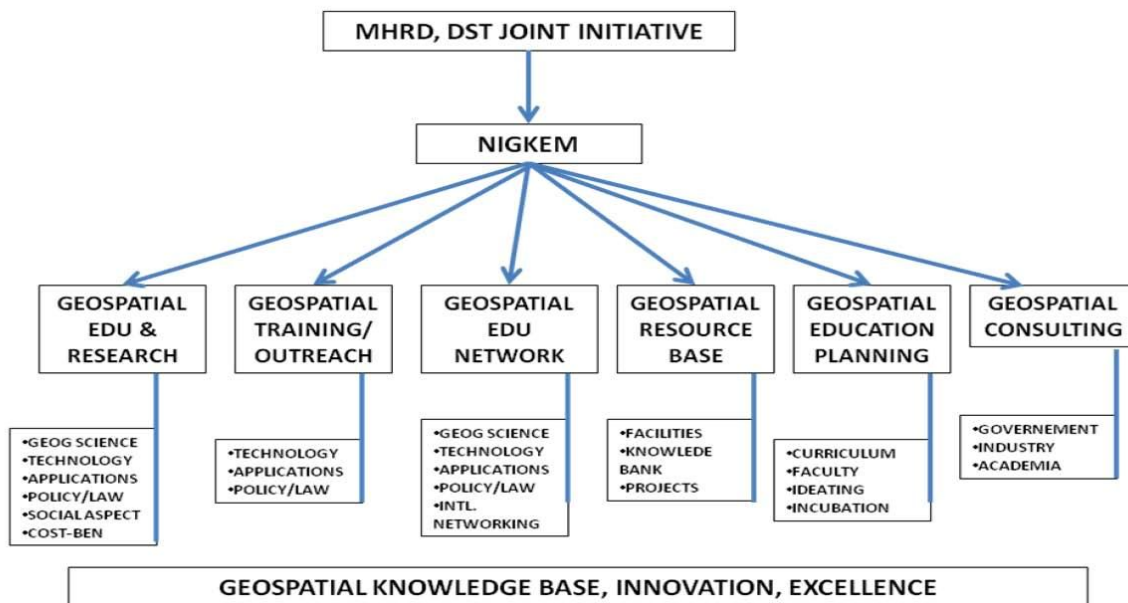
enable a clearing-house - as a regionally distributed technology infrastructure to share resources in geospatial technology.

- **Faculty Development and Outreach:** NIGKEM will also provide associated universities/colleges/schools with specialised faculty development and help and guide geospatial educators in positioning new and advanced concepts amongst students and citizen communities.

- **Student Engagement**: NIGKEM will undertake, encourage and lend its support in increasing the number, diversity and quality of students participating in and completing geospatial technology and application courses and programmes of study in under-graduate, post-graduate, doctoral and post-doctoral awards. Towards this, NIGKEM must take up bachelors, masters and research courses in basic geographic science and key research areas that emerge.

- **Geospatial Policy and Practices research and inputs**: A focussed programme of NIGKEM would be in geospatial policy and practices inputs to government, industry etc. that help the nation position its policy well and enable international and multi-lateral cooperation.

- Support the capacity-building needs of National GIS

6.4.3 Focus

57. The Task Force envisaged six areas of focus for NIGKEM:

- High-end and advanced research and science education (bachelors and masters) in geographical science disciplines – creating excellence and knowledge value for core geospatial technology areas.

- Developing and maintaining a state-of-the-art education resource base – curricula, facilities, projects, faculty etc. which can, on the one hand, undertake research and education and on the other, help university networking

- Education Networking – create a common platform or consortium of universities for expanding and enhancing the graduate and post-graduate programmes and enable developing of their own capabilities.

- Planning geospatial education for excellence

- Conduct specific and specialised advanced training and orientation programmes in geospatial technology and education – for government, private industry and for faculty training for universities.

- Consulting to government and creating assessments/evaluation and independent documents/reports related to geospatial technology.

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                    ┌─────────────────────────────┐
                    │  MHRD, DST JOINT INITIATIVE │
                    └─────────────────────────────┘
                                 │
                           ┌──────────┐
                           │  NIGKEM  │
                           └──────────┘
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GEOSPATIAL EDU & RESEARCH	GEOSPATIAL TRAINING/ OUTREACH	GEOSPATIAL EDU NETWORK	GEOSPATIAL RESOURCE BASE	GEOSPATIAL EDUCATION PLANNING	GEOSPATIAL CONSULTING
•GEOG SCIENCE •TECHNOLOGY •APPLICATIONS •POLICY/LAW •SOCIAL ASPECT •COST-BEN	•TECHNOLOGY •APPLICATIONS •POLICY/LAW	•GEOG SCIENCE •TECHNOLOGY •APPLICATIONS •POLICY/LAW •INTL. NETWORKING	•FACILITIES •KNOWLEDE BANK •PROJECTS	•CURRICULUM •FACULTY •IDEATING •INCUBATION	•GOVERNEMENT •INDUSTRY •ACADEMIA

GEOSPATIAL KNOWLEDGE BASE, INNOVATION, EXCELLENCE

6.4.4. Relationships

58. The Task Force noted that MHRD, MST, MOES, Ministry of Communications and IT have entered into a grand alliance which can provide a framework in establishing such an institution. The Task Force recommends that both MST and MHRD must jointly position this knowledge initiative – especially as it involves two major areas of expertise – geospatial technology, that MST can anchor, and institutionalising of knowledge/education, that MHRD can anchor.

59. The Task Force urges the Planning Commission to recognise this initiative, which can enable and help in meeting the larger objectives of MHRD and DST.

60. This institution will be successful as an autonomous institution and will thrive as an institution of national importance. This will be a major effort and a new way of human resources development in geospatial technology, which will benefit in positioning knowledgeable and skilled workforce for national requirements.

61. Key experts with merit, knowledge and experience in geospatial technology could be inducted into this institute from government or industry or academia and given

the intellectual and professional flexibility to develop the requisite geospatial technology knowledge base.

- The Institute can develop a matrix relationship with other entities like universities – as collaborators in furthering and enhancing geospatial education; industry – for usage of resources; government – for consulting, assessment and reports; and international institutes – for leadership initiatives.

6.4.5 Broad costs

62. At a broad level, such an Institute would require support to the extent of about Rs 200 crore for meeting capital costs and a recurring expenditure of Rs 50 crore per annum.

7. BROAD IMPLEMENTATION STRATEGY

63. The Task Force recommends that implementation of the four major facets of the recommendations would be best done through the mechanisms within MHRD – in alliance with other relevant agencies – like DST and Planning Commission.

64. The Task Force recommends that a high-level Management Council, chaired by Minister, HRD and co-chaired by Member (Science), Planning Commission/ Chairman, National Task Force (so that the continuity of the Task Force recommendations to implementation level is assured) and with Secretaries of DST, MoES, MHRD, Planning Commission and other relevant ministries, a few experts in education field etc., be established to guide, supervise, coordinate and ensure implementation of the strategic steps recommended.

65. Appropriate linkages and dove-tailing with National GIS/INGO activities be ensured.

66. Under the MMC, there could be four projects as under:

- School Geospatial Education Project (SGEP) – led by the Department of School Education, MHRD and responsible for school-level geospatial education activity.

The project should be tasked to achieve a performance target in 5 years. Funds for the project could be forthcoming as a special project fund from MHRD.

- Geospatial University Networking Project (GUNP) – led by the Department of Higher Education, MHRD and targeted to create university capacities as per the performance targets. The project can look at the existing facilities and establish new universities for B.Tech/M.Tech and PhD programmes, in coordination with NIGKEM, and address issues of curricula, facilities, faculty etc.

- Geospatial Training and Outreach Project (GTOP) – led by DST. The project can create a network of training institutes on a standardised curricula and assessments to create the cadre of users trained. The project could involve existing institutions and private industry appropriately. Funds for this project could be seeded by MHRD/INGO but could be pooled through the programmatic funds of different Ministries/State government (like funds of JNNURM for urban; MNREGA for rural; NHM for health; NRLMP for Land Records and so on). MHRD can link this with other Ministries to create the operational fund pool required.

- NIGKEM project – led by MHRD and DST - To start with a Centre for Geospatial Technologies and Research with the seed funding from DST could be established with affiliation to any IIT or Central University. Simultaneously, a legislation to establish NIGKEM could be tabled in the Parliament with this centre as the nucleus.

67. Task Force recommends that good agencies also be involved for mid-term evaluation and assessment of the progress of these projects in an independent manner.

68. As a broad estimate, Task Force suggests a total outlay as follows:

Project	Target for 5 years	Funds Required (in INR crore) for 5 years	Pool Outlay (in INR Crore) from other Ministries/States
School Geospatial Education Project (SGEP)	50, 000 schools	500.00	-
Geospatial University Networking Project (GUNP)	80-100 universities and ~5000 students	500.00	-
Geospatial Training and Outreach Project (GTOP)	500,000 trained persons in central/states	100.00	1000.00
NIGKEM	Knowledge Centre for Geospatial technology and Application incubation and national-level strategic capability	450.00	-

69. The recommendations can be implemented in 5 years and properly linked with the 12th Plan programme.

8. SUMMARY OF RECOMMENDATIONS

70. The following recommendations are made by the Task Force:

- A strategic approach to geospatial education must be adopted.

- A high-level management council be established, with Minister, MHRD as Chair and Member (Science), Planning Commission as Co-Chair with various Secretaries as Members and experts as Members, for guiding and supervising the implementation of recommendations.

- Appropriate linkages and dove-tailing activities with National GIS/INGO

- Four projects are recommended - School Geospatial Education Project (SGEP) – led by the Department of School Education, MHRD; Geospatial University Networking Project (GUNP) – led by the Department of Higher Education, MHRD; Geospatial Training and Outreach Project (GTOP) – led by DST; and NIGKEM project – led by MHRD and DST. Details of these projects and actions are given in Section 5.0 and 6.0 of report Volume – I and also in respective sections of Volume-II.

- NIGKEM project – led by MHRD and DST -To start with a Centre for Geospatial Technologies and Research with the seed funding from DST could be established with affiliation to any IIT or Central University. Simultaneously, a legislation to establish NIGKEM could be tabled in the Parliament with this centre as the nucleus.

- Financial outlay for the above recommendations may be coordinated by MHRD and DST on a direct basis and MHRD may coordinate with Planning Commission for outlay pool in various ministries for training. Details in Section 6.0 of the report.

71. Task Force also recognises that there are many a reform actions that are required and these may be required to be implemented by various structural mechanisms by MHRD:

- CBSE and NCERT must include geospatial technology in middle and high-school curricula. Efforts must be made to constantly update the same due to changing technology environment.

- MHRD must coordinate with state school boards for a similar inclusion.

- School-level teachers' orientation for geospatial technologies may be included by CBSE, NCERT and state boards.

- Some identified agencies may be tasked to develop prototypes of school geospatial kits. These could be evaluated and assessed and then MHRD could transfer the same for productionisation.

- Strong usage of web resources at school level (even creating a web resources directory).

- Universities must be encouraged to standardise curricula.

- University faculty orientation at regular intervals is required and must be taken up by MHRD – private educational institutions could help in this.

- Wide usage of low-cost, public-domain software and hardware resources must be encouraged. Industries must come out with such education products that can be used at university levels.

- Universities must have access to a wide variety of software and hardware resources

- Geospatial technology and applications must form a part of civil-services academies and re-orientation programmes – MHRD must take up the same with academies of various Indian civil services. Similar coordination and thrust is required with state academies.

- MHRD could coordinate with central ministries to ensure that training pools are dedicated to train government employees.

- Proper evaluation on the status of the projects needs to be carried out by involving professional agencies.

References

1. *Background Note for MHRD Task Force on Geospatial Education* –

   1st Meeting. November, 2010

2. *Prithvish Nag Committee Report of DST*, 2010

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6. ICG (2011) - Implementation of a National GIS under INGO—Programme document. A National GIS Vision document prepared by Planning Commission's Interim Core Group and published by Ministry of Earth Sciences in October, 2011.

No.17-21/2010-Policy Norms-I

Government of India
Ministry of Human Resource Development
Department of   Higher Education

New Delhi, dated the 15th October, 2010

ORDER

Subject: - Constitution of National Task Force on Evolving Geospatial Education Strategy

Geospatial Technology has found its utility and relevance in almost every walk of life and is being used in domains like infrastructure, utilities, banking, etc. This expansion has resulted in creating demand for a large number of professionals with different skills sets at various levels.Keeping in view of the importance of geospatial education, the Department of Higher Education, Government of India has decided to constitute a National Task Force with the following composition:

Chairman

1.   Dr. K. Kasturirangan, Member
       Planning Commission

Members

2.   Dr. Sukhdeo Thorat
       Chairman, UGC

3.   Maj. Gen. B. Nagrajan
       Director, Indian Institute of Survey and Mapping,
       Survey of India, Uppal, Hyderabad – 500 039

4.   Prof. S. S. Mantha,
      Acting Chairman
      All India Council for Technical Education (AICTE)

5.   Prof. Sanjay Govind Dhande,
      Director
      Indian Institute of Technology,
      Kanpur

6.   Prof. S. Sadagopan
      Director
      IIIT, Bangalore

7.   Mr.K. K. Singh
      Chairman & Chief Executive Officer
      Rolta India Ltd, Rolta Tower,
       Rolta Technology Park,
      MIDC, Marol, Andheri (East),Mumbai-400 093

8.   Dr. Rajendra S. Pawar
      Chairman
      NIIT-GIS, 85, Sector 32, Intuitional
      Gurgaon – 122 001

9.   Shri. Sanjay Kumar
      Chief Executive Officer
      GIS Development Pvt.Ltd.
      A-145, Sector -63 Noida (U.P) – 201 301

10.   Shri. Kaushik Chakaraborty
      Managing Director,
      Leica Geosystems Geospatial Imaging Pvt. Ltd.
      3rd floor, Enkay Square,
      448-A, Udyog Vihar, Phase V
      Gurgaon 122 016

11.   Mr. Tom Joseph
      Director-Education,
      Auto Desk India Pvt. Limited
      Divyasree Chambers, 2nd floor,
      Langford Road,
      Bangalore 560 025

12.   Dr. P. S. Roy
       Associate Director(CB) NRSC
       Indian Institute of Remote Sensing
       4, Kalidas Road, Dehradun -248 001
13.   Shri. N. K. Sinha
       Joint Secretary (DL)
       Deptt. Of Higher Education
       Govt. of India
14.   Major General Dr. R. Sivakumar
       Head
       National Resource Data Management System
       (NRDMS)
       Deptt. Of Science & Technology
       Technology Bhawan, New Mehroli Road
       New Delhi – 110 016
15.   Prof. A. K. Gosain
       Deptt. Of Civil Engg.
       IIT Delhi
16.   Shri. Mukund Rao,
       Chief GIS Consultant and Ex-President of GSDI
       81, 4th Cross Ramaroa Layout
       BSK 3rd State, Bangalofre-560 085

Member Secretary

17.   Shri. Amit Khare
       Joint Secretary
       Deptt. Of Higher Education**.**

2.   The terms of reference of the Task Force are as follows:-

       1.   To prepare a national strategy for geospatial education in the country and recommend implementation of geospatial education programmes at desired levels;

       2.   To identify and assess the overall requirements of human resources in growing geospatial industry;

3.   To develop and design geospatial oriented educational programmes for technical and non-technical institutions;

4.   To provide overall guiding framework for development and implementation of National Geospatial education strategy;

5.   To make recommendations on such matters that may be relevant for the implementation of national geospatial education strategy.

3.   The Non-official Members of the Task Force shall be paid TA/.DA at the rate applicable to such Members in accordance with Rules. The expenditure shall be met from the relevant budget head under Office Expenses(Non-Plan) of the Department of Higher Education.

4.   The Task Force shall meet as often as may be convenient to Members. The Task Force may devise its own process and methodology for its function.

5.   The Task Force shall submit its Report/ Recommendations by 31st March 2011 .

6.   The Ministry of Human Resource Development, Department of Higher Education shall provide all secretarial and other administrative support to Members of the Task Force.

7.   This issues with the approval of Secretary (Higher Education) and IFD vide Dy.No. 4741 dated 7-10-2010.

(G.S. BOTHYAL)
JOINT SECRETARY (POLICY)

To

1.   All Members of the National Task Force on Evolving Geospatial Education Strategy

2.   All Attached /Subordinate Offices and Autonomous Statutory Bodies under the Ministry of Human Resource Development

3.   President's Secretariat, Rashtrapathi Bhawan, New Delhi

4.   Prime Minister's Office, South Block, New Delhi

5.   Cabinet Secretariat, Rashtrapathi Bhawan, New Delhi

6.   Lok Sabha Secretariat, Parliament House Annexe, New Delhi.

7.   Rajya Sabha Secretariat, Parliament House Annexe, New Delhi.

Copy to:

1.   PS to HRM/PS to MOS (HRD)

2.   PPS to Secretary(HE)/PPS to Secretary (SE&L)/PS to AS (HE)/PS to AS (T)PS to AS&FA

3.   AS (SE) JS (A&L)/JS (DL) JS (EE-I)JS (AE) EA(P)/EA(M)

4.   Webmaster, CMIS (for uploading in the Ministry's website)

5.   Guard File.

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(V. V. Johnson)
Under Secretary to the Govt. of India

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F.No.17-21/2010 – PN.I
Government of India
Ministry of Human Resource Development
Department of Higher Education

New Delhi, dated the 6ᵗʰ December, 2010

ORDER

Subject: **Constitution of National Task Force on Evolving Geospatial Education Strategy.**

National Task Force on Evolving Geospatial Education Strategy was constituted vide this Department's Order of even number dated 15ᵗʰ October 2010 under the Chairmanship of Dr. K. Kasturirangan, Member, Planning Commission. The first meeting of the Task Force was held on 29.11.2010. The Task Force after in-depth discussion on the subject decided to set up four Committees as per details given below:

- Geo-Spatial Education at School level
- Geo-Spatial Education at University level
- Geo-Spatial Awareness, Training and Outreach
- Indian Institute of Geo-spatial Technology

II. The Convener and member of the Committees are given as under:

1. **Geospatial Education at School level**

Convener

Shri. Kaushik Chakraborty, Managing Director, Leica Geosystems Geospatial Imaging India Private Limited

Members

Shri. Vineet Joshi, Chairman, Central Board of Secondary Education or his representative.

Shri. Hrishikesh Samant, Associate Professor, St Xavier College, Mumbai

2. Geospatial Education at University Level

Convener

Prof. S. S. Mantha, Chairman, All India Council for Technical Education

Members

Ms. N. A. Kazami, Secretary, University Grant Commission

Dr. Bharat Lohani, Associate Professor, I I T Kanpur

In addition, Convener will have option to consult following institutions

- Anna University
- Bhartidasan University

3. Geospatial Awareness, Training and Outreach

Convener

Dr. P. S. Roy, Dean, Indian Institute of Remote Sensing and Director UN Centre for Space, Science Technology and Education in Asia Pacific

Members

Shri. Rajesh C Mathur, Vice-Chairman, NIIT GIS Limited

Shri. T. P. Singh, Director, Bhaskarcharya Institute of Space Application and Geo-information, Gandhi Nagar

4.   Indian Institute of Geospatial Technology

Convener

Shri. Amit Khare, Joint Secretary, Department of HE

Members

Dr. R. Siva Kumar, CEO, NSDI and Head NRDMS, Department of Science and Technology

Shri. Sanjay Kumar, CEO, GIS Development

Shri. Mukund Rao, GIA Consultant

III.   Terms and Reference of the National Task Force are reproduced as under:

- To prepare a national strategy for geospatial education in the country and recommend implementation of geospatial education programme at desired levels;
- To identify and assess the overall requirements of human resources in growing geospatial industry;
- To development and design geospatial oriented educational programme for technical and non-technical institutions;
- To provide overall guiding framework for development and implementation of National Geospatial Education strategy;
- To make recommendations on such matters that may be relevant for the implementation of national geospatial education strategy.

IV.   While formulating the report, members of Committees are advised to take into account   terms and reference of the Task Force.

V.   The Committee shall submit its report/recommendations by 30th December 2010.

(G. S. Bothyal)
Joint Secretary (P&M)

Tel. No.23383214

To

1.   Shri Kaushik Chakraborty, Managing Director, Leica Geosystems Geospatial Imaging India Private Limited, 3rd Floor, Enkay Square, 448-A, Udyog Vihar Phase-V, Gurgaon – 122016.

2.   Shri. Vineet Joshi, Chairman, Central Board of Secondary Education, 2, Community Centre, Preet Vihar, New Delhi - 11092.

3.   Shri. Hrishikesh Samant, Associate Professor, St Xavier College, Mumbai.

4.   Prof. S. S. Mantha, Chairman, All India Council for Technical Education, 7th Floor, Chanderlok Building, Janpath, New Delhi – 110001.

5.   Ms. N. A. Kazami, Secretary, University Grant Commission, Bahadur Shah Zafar Marg, New Delhi – 110002.

6.   Dr. Bharat Lohani, Associate Professor, IIT-Kanpur, Kanpur - 208076

7.   Dr. P. S. Roy, Dean, Indian Institute of Remote Sensing and Director UN Centre for Space, Science Technology and Education in Asia Pacific, 4 Kalidas Road, Dehradun – 248001.

8.   Shri. Rajesh C. Mathur, Vice Chairman, NIIT GIS Limited, B-1/H 9, MCIE, New Delhi – 110044.

9.   Shri. T. P. Singh, Director, Bhaskarcharya Institute of Space Application and Geo-information, Gandhi Nagar – 382007, Gujarat

10.   Shri. Amit Khare, Joint Secretary, Department of Higher Education, Shastri Bhavan, New Delhi

11.   Dr. R. Siva Kumar, CEO, NSDI and Head, NRDMS, Department of Science and Technology, Technology Bhawan, New Mehrauli Road, New Delhi - 110016

12.   Shri. Sanjay Kumar, CEO, GIS Development Pvt. Ltd., A-145, Sector – 63, NOIDA – 201 301

13.   Shri. Mukund Rao, Chief, GIA Consultant and Ex-President of GSDI, 81, 4th Cross Ramaroa Layout, BSK 3 Stage, Bengaluru – 560085.

MINISTRY OF HUMAN RESOURCES DEVELOPMENT

NATIONAL TASK FORCE ON GEO-SPATIAL EDUCATION

1st MEETING: DISCUSSION NOTE

(Prepared by **Mukund Rao** (Mukund.k.rao@gmail.com) and
Sanjay Kumar (Sanjay.kumar@gisdevelopment.net)

1. INTRODUCTION AND OVERVIEW OF GIS

1. Geographical Information Systems (GIS) deals with technologies/processes/software-hardware/applications, related to data, that can be characterized to a location or spatially or to a geographic coordinate. GIS technology has evolved over the past 40-50 years into a sophisticated discipline that is inter-related and could encompass surveying/navigation methods, map-making and cartography, imaging and image interpretation, database and computing technology.

2. Geospatial technologies bring together information from multiple sources so that various types of development and what-if perspectives can be obtained for decision-making. In order to do this, the data is "tied" to a specific location on the Earth's surface and a coordinate system is used for this. Thus, layers of such data are generated for the same location coordinate and one can "see through" different data variables on a coordinate – enabling better correlative analysis and integration to GENERATE new information sets.

3. There are three different ways in which GIS can be viewed. The first is the database view – where the FOCUS is on organizing a database of maps/images as different layers in an efficient manner and retrieving/storing and managing them in the most flexible manner. The second view is the map view and FOCUS is essentially on creating/displaying/rendering most easily-understood maps/images and is what many see in terms of GIS products. The third GIS view is the model view, which consists of tools that are able to draw new geographic information from existing datasets and these new understandings can provide answers for many projects/human activities/ development/business.

4. In modern day parlance, GIS has made tremendous progress. GIS is not just about images and maps BUT also of a whole host of SPATIAL data representation of tabular attributes - all of which comprise the geo-spatial content. When these spatial datasets

are combined, a new paradigm of information regime gets created, bringing to fore new geographical relationships that enables visualizing spatial patterns in data, hitherto un-available, and bringing developmental perspectives right down to grass-roots level and also allowing for making better and qualified decisions. With the potential to construct and visualise maps, analyze information vis-à-vis its spatial attributes, create interactive queries and use results for easy decision-making, geospatial technologies are fast becoming the toolset of decision- makers, government, industry and citizens.

5. Applications of GIS, from its early origins, has been socially relevant and are towards supporting governance activities of government, preparing sustainable development strategies, enabling enterprises to better manage business processes and bringing geographical knowledge to citizens. Thus, GIS has considerable impact on the economies of local, regional, and national governments - by creating greater efficiency, more communication, and better decision- making with the use of maps and images. GIS is critical to many aspects of the governance and nation -building – it saves money, helps government administrators make better decisions and increases collaboration. GIS is now powering more open government and, thereby, leveraging economic and social development and reaching the gains of development to the neediest and the right place and also bringing in accountability and responsibility of public activities.

6. India is embarking on establishing a National GIS, which will have large ramifications of building a GIS Asset and positioning applications that are critical for governance, enterprise and citizen services.

7. Many developmental projects of the government have a major GIS element that is acting as a catalyst for the growth of geospatial industry. Corporate sector too is fuelling geospatial technology growth through enterprise GIS implementation in sectors like power, retail, infrastructure, oil & gas and telecom. From scales of economies too, GIS has tremendous opportunities. At the global level, the GIS industry is estimated to be about USD 2 billion in past years, with major share coming from GIS solution projects all over the world. Even in India, in the 11th Plan period, the government sector would be allocating/spending almost INR 5000 – 6000 crores on GIS activities, over the 5 years, in different projects of various central and state ministries.

8. Indian work-force capacity is also an interesting scenario. Studies have shown that the Indian geospatial industry has tremendous annual productive capacity, which is worth about INR 3000 - 4000 crores – though much of this works for projects from outside India, and just about 20% of this is presently allocated for Indian GIS projects. Thus, India has very good work-force in the field of GIS – not only servicing the global needs maximally but also supporting national needs.

9. The paradigm is to see how the future needs of GIS country can be met with human resources that are oriented to meet the requirements and also fuel newer technology elements for GIS activities. This National Task Force is to address this issue in its

entirety and bring to fore a strategy that can be implemented for GIS Education in the country.

2. HR FOR GIS ACTIVITIES IN INDIA

10. Presently, GIS education in India needs a major thrust and orientation to modern and future needs. Some of the positive elements of GIS education in India are through:

    a. Few Universities (like Anna University, Bhartidasam University, Symbiosis Institute, JNTU, Andhra University, Garhwal University etc. that offer grad courses in GIS and RS).

    b. Specialised institutions (like IIRS, Dehradun, SOI Training Institute and so on) that offer specialized training and education programmes.

    c. School- level exposure to GIS education is almost non-existent. However, in many other nations, the school-level GIS courses are quite intense and prevalent.

11. The above institutions (and maybe some more – a good inventory of these can be made by Task Force) are doing good work but are able to cater to limited numbers and technology needs.

12. Planned spending on domestic geospatial projects is almost as high as India's total productive capacity. So, internal geospatial growth will depend on two inter-related factors: how the Government of India spends its planned budgets, and how the industry develops capacity to meet internal demand.

13. Current government geospatial projects will require more skilled workers than are available or will be trained by the current education system. The National GIS programme will create a large demand for GIS skills – skills to establish the National GIS, skills in user-segment of government/enterprise and citizens for using N= and benefitting from national GIS and also in continuous innovations and expanding applications. The National GIS will create a skilled manpower demand of a high order.

14. Meeting the requirement of adequate workforce with the requisite skill set however, is a great challenge for the education sector. Geospatial education in India is still in a nascent stage and, unless more educational institutes start offering degrees in this field, there will be a severe human resource crunch.

15. The table below shows the GIS resource requirements for the Indian geospatial activity, including for National GIS, in the next five years:

Year	Survey/ Mapping expertise	Geo-database and GIS Apps expertise	Total GIS skilled-force requirement	Trained users development	University-level focus	School-level awareness
2010	35,000	13,000	48,000	Large number in central and state government	A large number of University courses leading to GIS degrees and research	GIS awareness from 10-12 level
2011	42,000	15,000	57,000			
2012	50,000	17,000	67,000			
2013	58,000	20,000	78,000			
2014	67,000	22,750	89,750			
2015	77,000	26,000	1,03,000			

16. The National GIS, being planned by India, has a major element for capacity-building in GIS and HR development through training, research and technology Innovation of GIS technology and applications in India. Meeting the needs of National GIS would be a major requirement.

17. As with any educational activity, GIS education too needs special attention from government to bring in the necessary policies, programmes, institutional frameworks, career opportunity schemes etc. so that India can generate a large pool of GIS expertise that can power many needs of future.

18. One would need a national curriculum in the GIS. Today, courses are being offered by some universities, leading to a graduate degree in Geoinformatics, some have gone as far as starting post-graduate courses. However, there are still major gaps that need to be bridged in the GIS education arena. The table below shows an assessment of skill-gaps in various GIS activities – this can provide a feel of the gaps that needs to be bridged.

GIS tasks	Leadership	Managerial skill	Technical Skills	Consulting and Systems Analysis	Research/ Modelling
Survey/Mapping	Low	Average	Very Good	Good	Low
Geodatabase development	Low	Very Good	Very Good	Good	Average
GIS Applications & S/w development	Low	Average	Average	Good	Average
Solution architecturing/ deployment	Aveage	Average	Good	Average	Low

19.   From the above, it can be seen that there are broad gaps in the capacity in the following areas in India:

a. Leadership in GIS projects, that can steer and culminate success in projects and require high technology and project management skills.

b. Managerial skills in GIS are good though larger number of these would be required in coming years.

c. Technical skills in Mapping/Surveying and geo-databases is quite good – both in quality and quantity. This is borne out by large number of out-sourced projects that are done.

d. Technical skills in GIS sw and applications development need enhancements. This is the knowledge area and requires ability of integrating multiple knowledge of maps, databases, computing and software development related to GIS

e. Consulting skills are quite good – mainly because of good retired persons, who act as consultants and bring their experience into projects. However, gaps in high-end knowledge Consulting is certainly less.

f. Research and Modelling is a weak area and requires major impetus. It is good research in GIS that can fuel knowledge activity and Modelling has to be at the core of "number crunching" operations in multi-parametric data.

20.   With considerable investments in GIS projects for development by government, there will be a quantum jump in manpower requirement at different levels - not only to meet huge local market needs but also to be a outsourcing hub to provide solutions and services worldwide. The manpower requirements can be categorized into 3 major categories:

a. Knowledgeable and expert work-force required in present time-frame (now to say next 2-3 years) to meet the emerging demand for various GIS projects and also for establishing National GIS

b. Creating a NextGen GIS cadre of professionals/researchers that can take on advanced and sophisticated GIS tasks (say in next 5-10 years) – not just for Indian market but also enhance the capacity provision for GIS projects from abroad.

c. Position programmes that can make the citizenry more aware of GIS and its potentials – through a broad-based school-level GIS Kitting and also a large and mass-level GIS resources that can make citizens GIS-savvy. Geographic inquiry and geographic information system (GIS) technology are important tools that help educators, students, and their institutions answer personal and community questions with local to global implications. Schools must include GIS in their curricula to help their students gain valuable background knowledge and skills with which to face global challenges.

3. BROAD DISCUSSION POINTS FOR NATIONAL TASK FORCE

21. To be able to address the above mentioned issue, we feel that again a multi-pronged approach at implementation is called for:

a. A large training/orientation activity that can turn-around the present generation of users and professionals to the large needs of the GIS activities in India. This is best done by having a Training hub – a network of 3-4 institutes that can take up large number of training/orientation on standard curricula. This can be oriented to government, private and academic professionals and should be able to cater to the immediate 2-3 years' needs.

b. GIS Education and Research thrust at University level, by way of graduate and under-graduate courses and focused research in Geospatial technologies – where the curricula is oriented to professional and career track and innovations. Such courses are best offered in Engineering and Sciences category. Maybe, the turn-over from these may have to be large to meet the demand over the next 5 years and later. Aim should also to be able to bring good Ph.d outputs from such efforts.

c. A large school-level GIS awareness programme at 10-12 level, with focus on a good topic-categorisation in Science/Geography streams. The focus must be on

GIS technology, applications and even some hands-on kits for students. This may also require material development, training of teachers and so on.

d. A massive automated drive at citizen-awareness of geospatial concepts (taking cue from Google maps) by establishing public-oriented GIS Portals and Services for citizens. Specialised information kits and FAQs could be also positioned.

22. To implement the above, some of the actions that may have to be taken are as follows (these are broad definitions and each would have its own detailed perspective – which the TF can debate and arrive at):

- Position a National GIS Education Strategy direction (through this Task Force) – a long-term vision for GIS education. This must take care of trained and skilled work-force needs for the next 10-20 years.

- Plan and Implement a target-oriented focus on GIS trained personnel for GIS capacity- building within the government – especially in Ministries related to Agriculture, Water Resources, Forests and Environment, Rural Development, Planning, Urban Development, Geology and Mines, Municipalities of cities, Industries, E-Governance and meeting the needs of National GIS.

- Plan and implement a focussed GIS education at 10-12 grade of schools – with definition of curricula, GIS Kits, facilities, training of teachers and so on. Target must be to reach out to all schools in the next 1-2 years and bring about large-scale awareness.

- Plan, Implement and enhance grad and under-grad GIS education courses at Universities – with definition of off-take, national level curricula design, facilities, faculties etc.. This must start impacting the GIS work-force demand in next 5 years.

- Establishment of a National Institute of Geospatial Education, Research and Training as a national hub of education, training and high-quality research. Private participation in this can be considered.

- Continuous efforts at curricula improvements/enhancements, based on rapid technological growth. This is very critical and important to keep pace at the international level.

- Enhance financial allocation for HR in GIS to address schools-level, university-level and professional-level requirements.

- Private Industry to be promoted to provide a platform for internship assignments for grad and under-grad students.

- Encourage use of modern education tools – Distance Education, Education on the Web, network- based examination systems etc. in GIS Education arena.

- Promote private sector participation and investments in GIS Education activities – especially in National Institute of Geospatial Education, Research and Training, material and course development and also in faculty exchange.

The Task Force may discuss the above (apart from any other input from other Members) in its 1ˢᵗ Meeting and take up actions for formulating its recommendations.

Volume II

REPORT OF

SUB-COMMITTEES OF
TASK FORCE ON GEOSPATIAL EDUCATION

Contents of Volume II

1. Sub-Committee Report - Geospatial Education at School-Level

(Prepared by **Shri Kaushik Chakraborty** (kaushik@erdas.com) and **Dr Hrishikesh Samant** (hrishikesh@gisdevelopment.net) **with support from Shri Vineet Joshi,** Chairman, Central Board of Secondary Education, and valuable feedback from Mrs Arunima Suresh, AEO, Central Board of Secondary Education

INTRODUCTION AND OVERVIEW

a. Geographic Information Systems take features of the earth and represent them on a computer. One can use GIS software to interact with these features of the earth; visualize data, analyse data, query and manage data, observe patterns, identify features and create one's own virtual map layers to allow even more relevant analysis of local issues. Geospatial technologies bring together information from multiple sources so that various types of development and what - if perspectives can be obtained for decision-making. In order to do this, the data is "tied" to a specific location on the Earth's surface and a coordinate system is used for this. Thus, layers of such data are generated for the same location coordinate and one can "see through" different data variables on a coordinate – enabling better correlative analysis and integration to GENERATE new information sets. In summary, GIS is a system that involves software, hardware, data and a thinking user. It allows the user to overlay pieces of data and look for relationships between the data.

b. **Benefits for Students**

GIS and Geospatial technologies can help our students acquire knowledge and understand their world and surroundings in ways they never have before. Through the understanding of geospatial technologies we enhance their ability to think critically about a huge range of issues and topics that have relevance in their day-to-day lives, most importantly → What's happening to the environment around me?, How can we better plan our cities and villages?, How do we provide better transportation ? etc. Through the understanding of GIS, we are helping them increase their spatial literacy. This refers to one's ability to understand the relationship between things in a spatial sense; that is, how they relate to each other physically. For more information on this concept, follow the link http://www.nap.edu/catalog.php?record_id=11019 to a great

resource that has been developed by the National Research Council in the US called "Learning to Think Spatially: GIS as a support system in the K-12 curriculum". By exposing our children to the learning of GIS and related geospatial technologies, we are giving them current and relevant workplace skills. Students, who are better "spatial thinkers" and have the relevant basic understanding of the outcomes of GIS education, can go on in their future workplaces to use the basics of using geospatial technologies for applications in Urban Planning, Forestry, Agriculture and Food Production, Telecommunications, Disaster Management, Defence and homeland protection, Environmental Sciences and Protection, Mapping, etc. All these disciplines are of extreme importance to our nation today as we work on the next generation plans for our cities, towns and villages and plan to take India into the future.

Status of Current Scenario in School Education

The Country needs technically competent employees to enter all departments of government and public sector responsible for mapping, planning, managing our nation's infrastructure, natural resources and man-made assets. The only way to mould a change and accelerate the induction of GIS into the workforce is to Enforce the strategy of "Catch em Young" → Introduce GIS and geospatial education via the Geography curriculum.

Based on discussions with the CBSE board Chairman and Dr. Arunima Suresh we have the following data.

1. Status of Geospatial Education in CBSE –

    At present it is offered as part of the following subjects:

    a. Geography as an elective subject in Senior Secondary Syllabus

    b. Geospatial Technology as a vocational/additional elective subject in Senior Secondary Syllabus

    c. Geospatial Technology was introduced as a pilot project as Vocational Subject/ Additional. Elective Subject in Class XI in 2010. Four CBSE affiliated schools of CBSE registered for the course in 2010.

    d. Based on the positive feedback received from the pilot project schools and on the basis of overwhelming response from other independent schools, the Board is seriously considering the decision to open it to all affiliated schools in the country and abroad from the academic session 2011-12 for class XI.

2. GIS and Geography; Issues and Concerns –

Based on Interviews with teachers and students from Schools in NCR/Mumbai/Kolkatta the following feedback was summarized of geography at various schools across the country by Dr. Hrishikesh Samant we present the following -

a. There is no fundamental understanding of spatial context, the ability to read a map, concept of terrain and use of geospatial at the secondary school levels.

b. One the biggest impediments to the teaching of GIS Is the availability of trained and motivated teachers, who can spark interest in students and make the subject interesting. Schools do not have trained 'geography' teachers. Graduates in History, English or some other subjects are teaching 'geography'.

c. Geography teaching and text books today are extremely text based and teaching is not very graphical OR map based. This will require a revision of the materials to make it more interactive and interesting so that geography becomes a "fun" subject and teaching of concepts becomes more relevant than rote learning of facts.

d. The teaching of geography is part of social studies; in itself, it is not a first-rung subject in our country. There is little focus on explaining the applications of many of the themes and topics. Concentration is on textual matter and rote learning.

e. Topography as a concept is the most difficult to understand as students have a block or find it conceptually difficult to visualize in 3D, based on the way they are taught geography today. Therefore, understanding of applications in future work life especially relating to construction, civil engineering, planning, defence will be compromised.

f. Many schools even in urban India lack basic facilities, like a PC with a projection system, and access to the internet (in connection with the suggestion that free facilities like Bhuvan, Google Earth be used). As a result, most students are not exposed to free on-line resources, like Bhuvan and Google Earth, in schools today to teach geography

g. There is little teaching of the applications of Geography, Mapping, in day to day life to students, as a result of which spatial thinking and the ability to inherently read a map is not prevalent amongst most Indian students today.

Recommendations and Strategy for Introduction of Geospatial Education at the School level

A feasible way ahead is to incorporate both "map sense" and "spatial thinking" at an early age. It has to be done by a policy of 'inclusion'. GIS and the understanding of Geospatial technologies cannot or rather should not be taught as a separate subject at junior school level. The expectation from any student in junior school (K 10), is the ability to spatially relate with their surroundings.

a. GIS teaching in Schools →

Based on the Educational Concept of "I hear and I forget; I see and I remember; I do and I understand", we strongly recommend the introduction of interactive, application-based curriculum with a strong project based approach within the geography and science curriculum from Class 3 onwards. Aim of these will be to introduce the fundamental understanding of spatial context, the ability to read a map, concept of terrain, basic uses of GPS and location-based services, and the applications of geospatial technologies in day-to-day life. The formalization of the same should be along with NCERT and CBSE board.

b. The geospatial themes and concepts should be spread across the Geography, mathematics and science curriculum. This will give these topics greater importance; especially amongst parents. For example -

   i. Concepts of geodesy should be introduced in Sr. Secondary mathematics curriculum

   ii. Concepts of Terrain and 3D should be introduced in Sr. Secondary physics curriculum

c. The School Geospatial Kit →

In order to promote the learning of Geospatial concepts and themes and to undertake the various projects/activities, we recommend the Creation of a Basic Geospatial K10 Kit for Secondary Schools up to the major district level schools. Students shall have basic course material, containing fundamentals and overview of geospatial technologies and their applications in modern day life; Maps and Satellite images (either via Internet -based Bhuvan/Google Earth or as hard copy for those schools without internet / PC access); Basic GPS devices ; hard copy prints of the maps or the area surrounding the school; "Learning to Think Spatially" document which can be downloaded from

http://www.nap.edu/catalog.php?record_id=11019

d. Introduction of GIS education (project based and interactive) within the summer camps which are conducted during summer vacations by many Schools. This will include doing simple projects during summer vacations like "Map My Neighborhood", Using Bhuvan/Google Earth etc.

e. Make learning of geography using Bhuvan/Google Earth mandatory for all urban schools especially those with access to Computers and Internet.

f. The Geospatial Elective for Class 11 and 12 should be offered in all CBSE schools and to students of science/arts and commerce streams.

g. The curriculum of the geospatial elective for Class 11-12 is too complex and goes into teaching advanced subjects in Image processing, topography, GIS applications. We recommend that the Class 11-12 Geospatial elective should focus on teaching advanced topics and applications and not the different GIS software packages. Advanced topics like photogrammetry should be deferred to college level.

h. Measures should be undertaken to raise teacher/parental awareness towards GIS as a subject. This can be done through publishing a series of short introductory papers in various educational journals by describing what GIS is, how it can be used and where it can fit into the school Geography Curriculum.

i. Teacher Training →

All the above recommendations are really ineffective unless the country allocates funding for teacher training to teach the Geospatial concepts in Schools. We recommend that teachers be trained on the Geospatial Kit and the basic applications at the District level Teacher Training centres every year. Keeping in view the multidisciplinary nature of Geospatial education, training workshops should be conducted for teachers of Geography, Science, Mathematics, Computer Science etc.so as to equip them to teach this subject. The GIS program should be only introduced in those schools which have a trained and qualified teacher to train students on the same.

GIS Education In Secondary Schools - A possible methodology

Assumptions: the school has a teacher who has geography as one of the subjects in graduation.

Geospatial Education from grade 3 to 5

Grade 3:

As part of geography - get all students to create a sketch map of their own school. Prominent landmarks like the playground, their class room, principal's office, and library should be marked. The concept of relative location has to be introduced. Concept of scale is NOT important at this stage.

The exercise done by every student has to be preserved for further use.

Time required: about six hours, spread over a span of six weeks.

GRADE 4:

Keeping the output from the previous exercise in mind, the student will add to the school map features around the school, like the road, immediately adjacent houses, bus stop, utility facilities, such as shops next to the school, post box etc.

Note- as the exercise is done over a limited area on paper, the basic concept of scale can now be introduced.

GRADE 5:

Keeping the previous maps with the student, we now give a group task to students who stay in close by areas. Each group will prepare a road map from their home locality to the school. Prominent landmarks and road directions are also to be kept in mind. Attempt should be to make this map to scale.

Grade 6:

The concept of town map is to be introduced and the home to school maps prepared in the previous years should now be overlaid. Places of importance are to be located and mapped on this combined map. The use of a web GIS application like Bhuvan/ Google earth is to be introduced so as to check the general accuracy of the student made map.

Apart from just geography, the history teacher too has a role to play. All places mentioned in the history books should be shown on Google earth so that the student can relate to them from where he stays.

Grades 7 to 9:

These three years should be utilized to familiarize every student with topo sheets, satellite images of the area where the school is located.

The concept of topography should be taught not by using just contours, but by using 3D fly available freely today using Bhuvan.

In grades 9 and 10, the students should be able to sketch the approximate shape of the topography and be able to draw a profile. The concept of latitude and longitude grids, introduction to GPS (just the utility) - all this is to be incorporated in geography but should also be used when teaching history to bring home the importance of the spatial factor.

In Grade 10, the concept of geodesy should be introduced in mathematics lessons.

2.   Concept note on University-level Geospatial education

1. Background

This note is prepared by the committee, formed as a sub-committee of National Task Force on Geospatial education of MHRD, to look into the changes that are required to be made in the Geospatial education at University-level.   The sub-committee met on 2 February 2011 at AICTE.   The following members and special invitees attended the meeting:

1. Prof. S. S. Mantha, Chairman, AICTE
2. Ms. N. A. Kazmi, Secretary, UGC
3. Prof. P. K. Garg, IIT Roorkee
4. Dr. Bharat Lohani, IIT Kanpur
5. Dr. S. G. Bhirud, AICTE
6. Dr. R. M. Kumar, UGC

Dr. Bharat Lohani made a presentation on the concept note that was prepared and circulated to members earlier. Members discussed the note and arrived at some recommendations. The following is the updated concept note on University-level Geospatial education which will be circulated to the members of MHRD-NTF for discussions during its next meeting.

2. Geospatial technology

Description of Geospatial technology is not the aim of this report. However, to put the Geospatial education in the right perspective, this is being done here very briefly.

Several aspects of Geospatial technology have already touched the life of common people, e.g., Google Earth, GPS-enabled Mobiles and day-to-day navigation, using maps. All the technologies behind these services, when put in one basket, can be justifiably described as "Geospatial technology". This includes satellite remote sensing, airborne remote sensing, photogrammetry, geographical information system (GIS), global positioning system(GPS), electronic surveying, laser scanning, mobile mapping, image processing, algorithms, data structures and computer programming.   Geospatial technology touches around 80% of human activities knowingly or unknowingly. Geospatial technologies have high potential for better management and monitoring of day -to-day activities and short-term and long-term physical processes that affect our living

environment. Besides finding the use in the day to day life of people, these technologies are becoming essential for a large number of application domains, e.g., environmental sciences, civil engineering, urban development and management, utilities, navigation, disaster management, forest, coastal zones, mining operations, entertainment, and many more.

A need is being felt in India to look at the education policy for Geospatial technology since, on account of increasing application of technology, there is a demand from industry and government for better trained persons. A rough estimate states that over the next 3-4 years there will be a need of over 100000 professionals in this area at different levels. Various organizations needing Geospatial professionals include: Govt Organizations like IIRS, SAC, NRSC, ISRO, State Space Application Center, RRSSC, DRDO (DTRL), ADIRIN, SOI, NATMO; Software Industries like ESRI, AUTOCAD, AUTODESK, ERDAS, BENTLEY, GOOGLE, MICROSOFT; Private Organizations like RMSI, TATA Consultancy, EICHER; Govt Undertakings like ONGC, SHELL, IOCL; Administrative units like MUNICIPALITIES, Town & Country Planning, Urban Authorities, Jal Nigam, PWD, Technical and Research Institutions (for teaching and R&D work) etc.

Barring a few places education in Geospatial technology has not been a thrust area in India. This leaves a vacuum in terms of skilled workers and knowledgeable professionals. The effort of MHRD-NTF is to develop a Geospatial education policy so the immediate and long-term needs of country can be visualized, strategized and filled. The following report is for the University level education in Geospatial technology.

3. Goal of University level Geospatial education

The goals of University level Geospatial education are as follows:

1. Award of Degree, Diploma and certificates to students.
2. Training of students on fundamentals of Geospatial technology including relevant fundamentals from mathematics and science.
3. Training of students on modern Geospatial tools, including equipments, software and related computer skills
4. Making students aware about the international best practices and standards
5. Preparing students to be employable and contribute in industries
6. Carrying out research and development in order to serve the needs of the country and elsewhere
7. Serving as a source of consultation to industry and government

4. What is not the goal of University

It should be made clear here that the Universities are not expected to engage in training of large work force of semi-skilled workers for engaging in mass work, requiring less expertise. Training for this can be done more appropriately by the ITIs, Polytechnics, professional societies and entrepreneurs.

5. Universities covered under the purview of this note

In view of the above, the following are considered within the purview of the recommendations made in this note:

1. IITS, IIMs, NITs, BITS, DCE and other equivalent institutes
2. Technical Universities and Colleges at central and state levels
3. Central and State Universities and colleges run by these

While the role of Universities is also outreach education, it is being kept out of this note as a separate committee will comment on this.

6. Three types of education

Geospatial education, as required for the country, can be categorized as the following these categories are based on the depth of content, duration of training and intended professional level of the students:

A. Education for industry

Industry needs, in general, professionals at three levels:

1. A large number of data processors and field surveyors who are semi-skilled
2. A good number of Project managers who are trained at better level and can lead the projects, and
3. Finally, very few at the top technical and managerial level having high level of education and expertise.

It is not the mandate of Universities to train people for a particular industry or on a particular tool set. Further, it is not expected that the Universities may be involved in the training for type 1 category of workers which is the role of ITIs, Polytechnics, societies and entrepreneurs.

Some Universities and, in particular, colleges under the Universities should be involved in training the type 2 category people.

Universities at higher level and IITs etc. are responsible for educating the type 3 category of students.

B. Education for core professionals to provide Geospatial backbone

The future of Indian Geospatial technology will only be secure if Universities are able to produce a highly skilled and knowledgeable set of students. This group will provide the much needed Geospatial backbone to the government and industry.

C. Education for research for developing technologies in India

Universities are also responsible for educating and mentoring this group of students who will form the Geospatial research network that will lead to pioneering research and development in this area.

7. Available courses in Universities

A brief review of the existing courses in the Universities indicates that the following types of programmes are available:

Course	Duration	Qualification required
Certificate	1 week to 3 months	10+2, BA / B. Sc.
PG Diploma	6 months to 1.5 years	B.Sc., M. Sc.
B. Tech.	4-5 years	10+2 with Science
M. Sc.	2 years	B. Sc. / BA
M. Tech.	2 years	B.Tech. or MSc
Ph. D.	Variable	M.Tech./M.Sc.

8. Current status of programmes vis-a-vis programmes abroad

While defining a vision for Geospatial education for India, it is prudent to see as to how the countries, which are doing well in this area, are running their education, and where India stands. The following table is generated by collecting data from Universities abroad and in India, which offer programmes in Geospatial technology. Around 45 Universities were selected for both groups.

The table clearly indicates that, in terms of numbers, the Indian Geospatial education lags far behind their international counterparts at Bachelor's level and Ph. D. level training.

Per cent (%)	B. Tech./BS	M. Tech/MS	M. Sc.	M. Phil.	Ph. D.	Others
Foreign(45)	48	23	43	2	80	7
Indian(45)	2	33	56	2	22	20

More emphasis on Master's level courses in India is due to the industry demand for these courses. However, in terms of employability of students, barring a few, these programmes are also not rated at par. The table clearly indicates that there is an immediate need to start B.Tech/BS programmes in Geospatial technology in the country.

9. An insight into Indian Geospatial education vis-a-vis future goals

The Indian Geospatial education, particularly at University level, needs a thorough analysis in order to identify its current status, lacunae, desired goals and road-map for the future. The following sections attempt this.

Symptoms

Currently, the education system is not performing at the desired level and for meeting the nation's needs. This is evident if we see the following symptoms in the current system:

1. Acute shortage of trained workers (at all levels) in industries.
2. Industries opening their own training schools to fill the gap.
3. Lack of confidence of industry in local professionals.
4. Only Basic algorithm or software being developed in India, purely from research point of view and not from the commercial angle.
5. Too many formalities and long time-consuming procedure for patenting the software/technology in India.
6. No standards are being originally written in India.
7. No basic equipments being manufactured in India.
8. All good students looking westwards for higher education.
9. Lack of trained faculty members in Indian Universities.
10. Dependence on foreigners or foreign trained professionals or foreign technologies for core Geospatial problem-solving. A few such problems for which we need professionals of high caliber can be listed as below:

    - Developing Gravity model for India
    - Re-defining Indian msl
    - Adjusting Indian GTS
    - Developing transformation model between Indian reference system and WGS84
    - India GIS development
    - NSDI development
    - Secure technical support to Indian defense organisations

Notwithstanding the above, there have been some remarkable successes by the Indian Geospatial community. However, barring these isolated success stories, the scene is, more of less, as described above.

Diagnosis

We are making an attempt to go to the root of the problem and identify the possible causes for the above status of education. The following appear the main reasons:

1.   History of importing technology and experts from abroad.

2.   Indian Geospatial work-force is mostly focused on providing services from India to outsourced jobs. Only recently, there is demand coming from India.

3.   No comprehensive education programme/ policy on Geospatial education.

4.   Limited availability of thorough foundation courses and further higher education options in this domain.

5.   Only recently, some programmes were launched/started to cater to the market need.

6.   No quality control on the mushrooming Geospatial certificate and PGD courses being provided by entrepreneurs or colleges.

7.   No recognition of trained experts in the field through certification thus leading to an absence of credible professional cadre.

8.   No demand by the government agencies for trained Geospatial experts to lead projects--thereby no such demand for trained experts.

9.   Failure of some educational institutions to cope with recent trends in technology, thus making their programmes and output obsolete.

10. No demand from industry for trained individuals of high caliber--as technology or solutions are being imported from abroad.

11. Limited exposure of government decision-makers on need, quality, standards for Geospatial services.

12. Restrictive Geospatial data policy hampers the efforts of Universities and researchers, thus leading to a negative environment. Further, non-availability of data in digital form by various field-based organizations / Govt. organizations.

10.   Goal

In view of the above discussion and realisation of the need of Geospatial experts in the country, we need to set few goals. The goals can be both short and long-term ones.

Short-term goals

Short term goals are for catering to the immediate needs of the nation to complete several ongoing Geospatial related projects. It is estimated that around 100,000 professionals will be required in next 4 to 5 years. Most of this manpower will be at data collection and data processing level. To cater to this need, the existing programmes of Universities need to be strengthened. The number of students may be increased and the facilities and faculty members will need to be inducted. The industry can participate by sending its experts to the Universities for training on tools that are not in the curriculum of the Universities.

However, the main goal of the Universities should not be confused with these short-term efforts. The Universities stand for much larger goals than to satisfy the immediate needs of the industry and these are the goals which will need long-term planning and strategizing.

Long-term goals

A vibrant University education system is fundamental for the nation to realize the full potential of Geospatial technology. Long-term vision and goals are needed, with a well-thought road-map, to provide a solid backbone of Geospatial experts to the country to solve its problems using Geospatial technology and for research and developing new tools in this domain. The following time-bound goals are being recommended for realization of the above in a span of 10 years.

Diploma level education

It was felt that none of the sub-committees under MHRD-NTF account for the Geospatial education for Diploma (Polytechnic) and sub-diploma (ITI) levels. However, it is well known that for driving any technology, professionals at these two levels are very crucial. The Government runs a large chain of Polytechnics governed by AICTE and, similarly, there is a further large chain of ITIs . Currently, barring the training on Land Surveying there is no other training from Geospatial domain provided to this cadre.

Recommendation for Diploma level education

It is recommended that around 20 polytechnics be chosen to train each year around 1000 diploma holders, who are trained during all three years of their course work on

various tools and software of Geospatial technology. The emphasis should be more on hands-on-training on tools at diploma level. Course curriculum can be designed at the level of AICTE and implemented uniformly at chosen Polytechnics. Similarly, at the ITI level, training can be provided on one of the tools, i.e., Land Surveying, GIS digitization, AutoCAD Operation, GPS operation and data processing, etc.

B. Tech. level course

Currently, only Anna University runs a B. Tech. level course in Geospatial technology. Through a study of Universities abroad, it was found that 50% of the Universities, that work in Geospatial domain, offer Bachelor's level programme. These courses are several decades' old and continue to produce experts who see Geospatial as their career option. These courses have seen ups and downs in terms of relevance and interest of students. However, the recent developments, that have made Geospatial technology an essential part of society, have generated keen interest in these programmes. These courses are designed in such a way that a student is exposed to the fundamentals of science, mathematics and computers, which are essential in Geospatial technology. Further, through course and laboratory work, a student is exposed to all domains of Geospatial technology, e.g., land surveying, Map Projection, Cartography, GPS, Geodesy, remote sensing (optical, thermal, microwave), Photogrammetry, Laser scanning, Geostatistics, GIS, Database management systems, Algorithm, Image Processing, and varied applications of these. These courses provide a solid foundation of all related fundamentals and transform a student into a complete Geospatial expert. These experts, at the end of their Bachelor's degree, may join industry to provide all-round technical support or proceed for higher studies, leading to M. Tech. or Ph. D.

Recommendations for B.Tech. level course

Currently, the Indian educational system is not producing professionals with this background and this, among other causes, is the reason for the current state of the professionals in Geospatial industry. The MHRD led NTF is an opportunity to address this issue and design and promote such programmes.

It is being recommended that at least two IITs and 2NITs should immediately (within the next two years) start this programme, with a total enrollment of 80 students. Further, the private engineering colleges should also be encouraged to start this programme. The institutes, running these programmes would require special support from the government for hiring faculty and establishing laboratory facilities.

This programme will help develop a core of professionals, with knowledge of the complete spectrum of Geospatial technology, for providing much needed high-caliber support to Government, Industry and Academia.

As per the trend and also the requirement, the B. Tech. degree can be continued as a dual degree for desirous students.

M. Tech./M. Sc. Level courses
The data on Indian Universities show that currently several institutions are running M.Tech./MSc courses in Geospatial technology. However, the points of concern in these courses are as under:

1. There is a large variation in the course content and course delivery. Only a few places emphasize on the fundamentals of the technology while a large number of courses are oriented on button-happy training on software.

2. There is a large variation on the intake qualification and area for these courses. This leaves the employer baffled with regard to the kinds of products being produced by these courses.

3. Several places running the course do not have basic infrastructure in terms of faculty and facility for conduct of the course. Consequently, the products from these courses are not employable and this leads to frustration on the part of both the students and the employer.

4. There is confusion whether a particular programme is technology oriented or application-oriented.

Recommendations for M. Tech. level courses
These courses are important to train those who have completed their B.Tech. degree in Geospatial technology for further enhancing their knowledge. These courses are very useful for those students of high caliber with B.Tech. in relevant branches of engineering or MSc in Mathematics or Physics who want to move to the Geospatial area. It is recommended that IITs, NITs and other engineering colleges of repute should conduct highly advanced M.Tech. level Geospatial courses. These courses should have more emphasis on technology rather than application. The detailed syllabus for these can be defined at the central level and, with little modification, can be pursued at the local level.

Recommendations for M. Sc. level courses

By its very nature, Geospatial technology is a useful tool for problem-solving in several application areas. M. Sc. level courses are required to train students on the basics of Geospatial technology and on its application to a particular set of domain. This course is suitable after B. Sc, M. Sc or B. Tech. in different areas, e.g., environmental science, botany, forestry, geography, agriculture, civil engineering, mining engineering etc.. A student will have a choice of moving to M. Tech. level course or joining industry or government after M. Sc. and using the technology in their application area. Different Universities can choose their application domain for these courses. The core curriculum for each application domain can be defined at the central level and, with little modification, can be implemented at local levels.

Ph. D. level courses

The comparative analysis of Geospatial education in India and abroad shows the dismal level of research programmes in India. While in the overseas context, around 80% Universities, offering courses   in Geospatial technology, also offer Ph. D. programme, this number is merely 22% in India.

Recommendations for Ph. D. level courses

The success of PhD level programme will depend on (a) attracting bright students for Ph.D. (b) working with industry or on industry supported research projects (c) adequate research infrastructure (d) developing a network of similar research institutes along with other national scientific bodies like NRSC, ISRO, ADRIN, DTRL, etc. for sharing of research ideas and facilities, (d) executing research collaborations with good Universities abroad, and finally (e) making the Ph. D. in Geospatial technology a much sought after course by ensuring employability of students in industry and government bodies.

No specific recommendation can be made for conduct of the Ph. D. programme as this is very much University specific. However, there is a need to set a target for the number of Ph. D.s that can be produced in the next 10 years. The Ph. D.s will also help as faculty position in new courses envisaged here.

11.   General recommendations

Besides the above recommendations, the following are a few other recommendations that is being made for acting as a catalyst in the success of the above vision.

1. Initiation of an Indian Geospatial Services (on the lines of IAS, IFS, IES, etc.)   will

attract students and also ensure supply of trained professionals for various government departments. These officers can be sent to several departments that need Geospatial experts.

2. AICTE, UGC, DST and other governing and funding agencies should declare Geospatial education and research as the thrust area.   This should be supported by special training of teachers, R&D funding, special programme initiation, development of centre of excellences etc.

3. There is a need to develop a unified curriculum at all suggested levels.   These curricula should be made available to the Universities for implementation, with minimal alterations. The institutes of higher learning should be exempted from this as more flexibility should be provided to quickly alter the course, as per the future need.

12. Summary of Recommendations /Road map

Programme	Current status	Target students	Purpose of course	Course content	Target Universities	Target Number vs. time	Remark
Diploma	Only Surveying in Civil Engineering	10 and 10+2 students	To prepare people with hands on training for working in field and Data processing	Basics of Geospatial Technology in certain areas, with more hands-on training	Polytechnics governed by AICTE	10000 Diplomas in next 10 years with 100 in each year	There should be good interaction or internship in industry
B. Tech.	Only 1 at Anna University	High caliber 10+2 students from science and maths background	To prepare core professionals in technology	Maths, Science, All basic technology courses	IITs, NITs, BITS and other engineering colleges with History and repute in this area	1000 B. Tech. in next 10 years with 100 in each year	This is highly recommended
M. Sc	At several places	B. Sc, B. A. from an application area	To train on basic tools and Application so one can use in ones domain	Basics of technology and tools and application methodology	Universities and degree colleges	20000 MSc in next 10 years with 200 in each year	There are enough number of courses but their course curriculum and training need to be upgraded
M. Tech.	At around 10 places	B. Tech. or M. Sc Students in relevant disciplines	To prepare professionals with advance level training on the Specific aspects of technology	Advance level training in sub-domains of Geospatial technology -Geodesy and GPS -Space borne remote	IITs, NITs, BITS and other engineering colleges with history and repute in this area	10000 M. Tech. in next 10 years with 1000 in each year	The current courses need to be re-designed and re- oriented, based on the available faculty and resources. New courses need to be started in other places.

| Ph. D. | Only at a few places | No specific qualification as it depends on the P h. D. programme/ the University/ application orientation etc. | To initiate development Of Geospatial technology and tools in India. Further, to use Geospatial tools for solving several application problems. | NA | All Universities with faculty members and facility. Further, more Universities to be encouraged to start PhD programme. | 250 Ph. D.s in next 10 years, of which one third should be in core Geospatial technology and rest on applications. | This will need special efforts from government by sponsoring more research projects to Universities in this area. Further, a special emphasis can be shown by enhanced facility or scholarship to students. Collaboration with foreign Universities to be encouraged. |

sensing
-Airborne remote sensing-
GIS-Close range remote sensing

and also General but advanced training on Geomatics

13. Conclusion

The main conclusions of this note are summarized below.

1. There is an urgent need to develop a vision and road map for Geospatial education in India.

2. In comparison to Universities abroad, the Indian Geospatial education seriously lags behind in training the core professionals and research scientists, who are necessary to drive the Geospatial industry and government projects and to carry out research and development in the country.

3. There is an immediate need to start few bachelor's level courses and strengthen the Ph. D. programme.

4. The course content and course delivery of existing Master's level courses need to be more focused to cater to the needs of nation in coming days and decade.

5. There is an urgent need for government to encourage Geospatial education and research through government support while facilitating the support from industry for these programmes.

6. To promote Geospatial technology and provide the much needed support to government, an Indian Geospatial Services can be started on the lines of other services.

3. Report of Sub Committee on Geospatial Awareness, training and outreach Under National Task Force on Evolving Geospatial Education Strategy

1. Background

With advances in geospatial technologies and the increasing availability of spatial data and services and the convergence of geospatial, information and communication technology, it is emerging as an affordable, effective and enabling technology to address numerous requirements of the knowledge society. The combination of geospatial technology, communication and information technology here is referred to as Geo-Information (GI) technology. Geospatial technology has established itself as an integral part of decision-making, related to planning and sustainable development. However, the sudden explosion of the technology in terms of its numerous outreach, has exposed the inadequacy of trained manpower who can build, integrate, maintain and upgrade such an system (at various levels starting from the global to local level) to fully realize the potential of this emerging technology. So far the technology and its application has reached a level of maturity and acceptance by the consistent effort put in by technical persons trained in computer science, communication technology and natural sciences. While cross cutting ideas from other disciplines were very fruitful at the nascent stage of the technology development, with the present advancement and known road map, it is imperative that the discipline develops itself by training manpower in the technology, for the technology and by the technology to meet the present and future demands of a knowledge society.

Training and education programmes on geospatial disciplines have grown tremendously over the past 20 years and many institutions/universities/private colleges are offering training programmes, which are largely biased towards one or few of the traditional areas of expertise in natural science, or computer science depending upon the department which is offering the course. Such kind of training often results in lopsided capacity-building that fails to meet the requirement of Geospatial technology and there exists a substantial gap between market demands and what is being offered by educational institutions, in terms of content, quality and future direction. Therefore, while welcoming the cross-cutting ideas from other disciplines, it is important to develop capacity in core areas of geoinformatics to meet the real challenge. In this endeavour, it is important to have direct communication between the government-industry, academia-industry and academia-government.

The first step in comprehensive capacity-building strategy is to assess the requirement of the market/industry and what is being offered by various agencies and prepare a road map for strengthening the geospatial awareness, training and education in India

2. Terms of Reference of the sub committee

1. To assess the present awareness and training programs on geospatial technology

2. Give recommendations for strengthening the geospatial awareness, training and outreach

3. Present Scenario

In order to assess the present level of geospatial training, awareness and to assess the gap areas, a questionnaire was prepared and sent to various Government/ Autonomous organizations and private institutions/ Universities institutions that are currently involved in training and awareness program. Most of the institutions, offering these courses, face the problem of non availability of professionally trained teachers. Most of the institutions do not have proper infrastructure (instrumentation, software etc.) and hence students do not get proper hands on experience, leading to lack of understanding and expertise in the application of this technology in various field and in integration of this technology with other modern technologies. Consequently, students are unable to find appropriate jobs. In some of the institutes, the course is centred / dependent around a single person. While offering such courses, the institutes ignore the competency of the faculty and the requirement of the students.

Table 1: Summary on training in GI technology and applications

Geospatial Technological Needs	Work force requirements	Geospatial Training In India	Gap areas
• Remote observation/ data acquisition • Information extraction (using RS) • GIS database preparation • Spatial data digitization • Application development • Information dissemination and content delivery • Web GIS/ Mobile GIS/ • Location Based Services (LBS)	• Decision makers well versed with GI • Technical trained personnel (three types- image processing / GIS/ database) • Domain experts with specialized knowledge in GI • GI content delivery experts (visual/ digital)/ Web GIS/ Cartography experts • Communication experts for data acquisition and dissemination	• More than 50 Govt/ Autonomous organizations/ private institutions/ colleges/ / universities are offering the following training programmes • Capsule training (3-10 days) • Short term certificate courses (2-3 months) • PG diploma (10 months to one year) • Special paper in a recognized degree course (commonly of 1 semester duration	• Variable course curriculum across the institutes offering GI courses • Lack of qualified faculty • Lack of infrastructure facilities • Lack of proper funding • Lack of proper marketing of the courses • Lack of practical knowledge • Lack of satellite data, other spatial data • Lack of understanding of Industry and Societal needs and latest developments

Summary

- Barring some leading institutes/colleges, most of the institutes/colleges lack in providing comprehensive training in the field of geospatial technology due to lack of proper infrastructure and trained faculty

- Lack of practical knowledge among the students pursuing training in geospatial technology as they do not get opportunities to work in live projects

- Variable course curriculum among institutes offering GI courses, which needs to be based on some standard curriculum, with at least 60 % of the course content to be similar.

- There is a substantial gap between market requirements and what is offered by the institutes providing Geospatial training.

  - Lack of industry-oriented program.

  - Too generic training i.e., lack of software-specific training. There should be a blend of generic and specific software-based training.

4. Emerging Scenario and strategies for GI training and awareness

4.1 Emerging Scenario

Geospatial technology plays a key role national infrastructure development, natural resource management etc.   Government has initiated extensive use of this technology in all possible fields.   Private industry has realized the benefits of this technology and are applying geospatial technology in their work and business processes. With the advancements in space technology and launch of many high resolution satellites, the demand for high-quality, up-to-date spatial data using remote sensing technology is growing rapidly and the use of RS data for near real time application would be the future. India is also catering to the needs of the overseas market in the field of geospatial technology by offering its services and solutions.

  i. **Vibrant Industry**: Vibrant IT and communication industry has established itself as a global player in execution and delivery of IT related services in an efficient manner at a most competitive cost. The established practices and service mechanisms have helped some of these key players to diversify into GI sector and replicate similar success stories. While attempting to meet the global and national requirement, the industry has faced the main problem of quality manpower at all levels to deliver the desired products/services.

ii. **Advancement of Space and Communication Technology**: Global space agencies including ISRO and many private companies, are acquiring large amount of spatial data at an unprecedented resolution through aero-space media and ground remote observations. Recent developments have shown that by using optical, microwave, thermal and LIDAR sensors very high-quality information on surface and sub-surface can be obtained on Earth, Moon, Mars and other planetary objects. However, to convert data to information requires high quality trained manpower to undertake development of new algorithms, processing routines and to analyze such data in a timely and routine manner for best utilization. There has been tremendous progress in communication technology and, with each passing day, new information is being delivered on hand-held devices, and possibilities are emerging on remote access, delivery mechanism and control system, with the help of GPS and hand held devices.

iii. **National imperatives**: Present emphasis on Infrastructure development, sustainable development and natural resource management calls for appropriate technology for quick assimilation, integration and well informed decision making. It requires huge amount of existing spatial data to be converted to GI standard besides development of appropriate processing and visualization tools for dissemination and analysis. It amounts to taking Bhuvan and NSDI efforts a step ahead for meeting national requirements and global imperatives.

iv. **Location Based Services (LBS):** LBS are one of the key applications of Geo spatial technologies. The rapid evolution of cell phone industry, from initial simple talk services to multiple functions of multimedia messaging and voice services, with the emergence of broadband wireless infrastructure has created tremendous demands for various location-based services.

v. **Growth in Education Sector**: The education sector is experiencing unprecedented growth and is poised to meet challenges of future requirement in IT, healthcare and other social sectors and the same mechanism and infrastructure can be utilized to meet the demand of GI sector.

vi. **Recent Initiatives**:

a. The GI and Remote Sensing technology has maintained their stride (thanks to recent government initiatives) and are moving from higher level of education to intermediate and secondary level, thus preparing the young aspirants, with sufficient background, to take the plunge. A multi-pronged strategy is required

for introducing GI in early education and strengthening the higher educational and research initiatives.

b. **EDUSAT**: ISRO's GSAT - 3, popularly known as EDUSAT, was launched in 2004 and has, since then, pioneered the cause of distance education from primary to professional level studies. Since 2007, EDUSAT network has been successfully used for outreach programs in Geospatial technology. Till date, around 148 universities are connected to the network and trained nearly 4098 students.

Most importantly, professional training must be considered as both result as well as input of such a multi-pronged strategy.

4.2 Need for enhancing geospatial training and awareness

Growth and sustenance of GI technology requires highly skilled and qualified geospatial scientists and professionals, with adequate knowledge of geospatial technology. The demand for trained manpower is increasing day-by-day, thus increasing the gap between demand and supply of quality trained manpower. This is mainly due to the fact that present training and educational infrastructure are not adequate and well equipped to meet the requirement of producing skilled professionals in geospatial technology.

The key issues in this regard are developing of capacity, in terms of trained manpower as per the following strategy:

4.2.1 Professional training programs at different levels

- **Trained decision-makers** who can set new paradigms in assimilation and formulation of strategy for infusion of GI technology and applications.

- **Image-processing technical experts** who can design new algorithms to process and derive relevant information from remotely sensed devices in an automated manner.

- **Data base experts/managers** who can integrate various types of spatial and non-spatial data in a manner/format/solution that is easy to access, up-to date data and maintain its integrity.

- **GI application developers/GIS experts with domain knowledge** who can develop new applications or implement proven methods of analysis (for present and future requirements) in a GI context by integrating RS and GIS databases.

- **Professional map/information providers,** who will make standards and design protocols for data (map and text) dissemination in print/ digital form without distortion and as per the requirement of intended use on hand-held devices/in internet.

- **ICT experts** who can play a key role in transferring the data/solutions (using various data compression techniques) to mobile units through advance communication protocols.

- **Data converters,** the work horse who can convert everything and anything to GI standards.

- **Recognition of training** is very important in government set-ups where trained staff must be provided with required facility and due encouragement to use GI for the benefit of the organization.

- **Organization of brain storming/ workshops/ seminars** is essential for deliberating on advantages and pitfalls of technology infusion and its impact on societal development.

4.2.2 Training of the trainers: Training for trainers (TOT) is a key element in every sphere of professional training as this can enhance the capacity of teachers/trainers in both industry and academia.

4.2.3 Awareness among general public: In the past few years, web services, such as Google Earth and Bhuvan, have generated incredible awareness and curiosity among the general public. However, the initial euphoria will result in higher demand for GI technology and this is only possible by making GI content most relevant, up-to-date and understandable.

- **GI Kiosks**: Touch screen kiosks are the order of the day and such terminals must be installed at all public utility places to provide services on utility and facility such as map details (direction and distance), neighbourhood condition, real state, local product etc.

- **Upgrading existing Kiosks to GI Kiosks**: There are numerous such touch screen kiosks at airports/ railway stations, that need to be upgraded to provide contextual GI services.

- **Essential services through GI**: Applications need to be developed to deliver relevant content in real time on mobile devices and two way communication

enabling spatial data updation and query will create a huge demand for such technology. In the private sector, there are many players to provide such services and in the government sector, NIC, IMD and NDMA can initiate such services for e-governance, weather services and disaster management, respectively.

- **GI and GPS enabled navigation:** Presently, rudimentary services are available on commercial and private vehicles. However, integrated services are required, with user inputs for better utilization of time and fuel.

4.2.4 Outreach programmes for school and colleges: The concept of "catch them young" must underline the strategy to mainstream GI in formal education to prepare for the future. Introducing school children to geospatial methods and technologies will improve GIS awareness and help develop a skill for the use in all scientific disciplines (geography, natural sciences etc.). It requires the following:

- **Space School:** As Space inputs are one of the important components of GI technology, it is envisaged to organize Space schools where in students can come on their holidays and experiment with space tools and products. ISRO and IIST can play an important role in this regard. This will eventually benefit GI technology.

- **GI Kits**: Children-worthy **"GI Kits"** are required, which should be fun to learn and not an extra burden. Special software and web learning tools must be developed by key private players like Educomp and government agencies, like CBSE and state boards.

- **GI as a Hobby**: Map-making and computer graphics can be offered as a hobby along with clay modelling etc.

- **GI exhibition:** School level GI exhibition and map-making competitions should be held, with remuneration in the form of software and hardware (no cash prizes).

- **GI as a special paper**: In higher classes and colleges, a special paper can be introduced appropriately. The idea is to mainstream the GI in formal education in a subtle manner i.e. neither an extra burden nor at the expense of important subjects/papers.

- **GI in ITI/vocational training**: Most importantly, in ITI and vocational training institutes, GI technology must be offered to meet the huge demand of data

converters or data creators "The butterflies". Otherwise it would be back to square one, where in highly trained qualified manpower will be under-utilized (in digitization) and will be paid less as a result of which it will become non-attractive to them. Overall, there will be lesser demand and, eventually, the main user industries and government would suffer.

5. Specific recommendations

5.1 **Professional training programmes**: To strengthen and make the professional training programmes more effective, the following measures are suggested:

- Content generation and standardization of curricula and evaluation for various levels of courses and involvement of academic, industry and govt. sectors to ensure quality and reduce demand-supply gap.

- Training in geospatial technology can be organised at the following different levels:

- Decision-Makers (1-3 day/s programmes)

- Middle level managers (1-2 week/s programme)

- Training in technology development and management at engineering and Masters' level

- Database creation (being done by ITIs)

- Training should focus on end-to-end solutions (convergence of technology), based on the application of GI technology.

- Closer industry-academia interaction for ensuring industry standard training programmes. However, it should be more generic in nature and should not aim at completely out sourcing industry HRD programme. For example

  - Exposure to mainstream IT, like RDBMS, Web tools etc. These skills are essential for any professional involved in a GIS project and, hence, these must form a part of GI course curriculum.

  - There is need for greater exposure to various domains and application areas like utilities, urban development, LBS, Business GIS, security etc.

- Introduce the concept of Practice school during Master Level/ Graduate Level Courses (as in Symbiosis Institute). It will allow students to work in an industry for a period of 4-6 months in order for training to be career oriented.

- The courses curricula should focus on exploring newer technology and emerging solutions.
- Emphasis should be on geospatial technology management.

Training of the trainers should be organized at different levels:

- **Senior level professors***:* Training senior level professors to enable them to do higher level of research
- **Graduate and Post graduate faculty***:* Training faculty involved in academic programmes and providing them with adequate content/material etc..
- **School Teachers***:* Training of high school teachers in GIS skills to enable them to use geospatial technology in teaching different subjects.

Centres of Excellence (CEs): It is envisaged to set up Centres of Excellence (CEs) will providing platform for advance training and research in GI. These centres should act as an interface between industry, academic and Government institutions.

- They should play a key role in standardization of course curricula, teaching and evaluation methods across the three educational levels (high school, intermediate college, and University level), designed to meet industry and research requirements.
- They should create a national network for dissemination of geospatial curriculum materials, resources and project reports.

5.2   Awareness and Outreach

In order to increase awareness and outreach of geospatial technology and its benefits among civil servants, other government officials in state and central government, public sector units, educational and research institutes, school children and general public, the following measures are suggested:

5.2.1 Awareness/outreach for general public

- Use of communication (e.g EDUSAT) and other contemporary technology (TV broadcast/DTH) for outreach and creating awareness of geospatial technology and its benefits
- HRD ministry to develop course material to promote awareness among people about the benefits of geospatial technology using —
  - Multimedia

- Mass media: (films, videos etc.)

- Making satellite images available in a mass-media publication

- Establish GI Kiosks

- Upgrading existing Kiosks to GI Kiosks

- Essential services through GI

- GI and GPS-enabled navigation

5.2.2 Awareness and outreach programme at schools

- Awareness on Geospatial technology should begin at school level. Spatial literacy is not about teaching GIS in schools. Rather, schools should introduce spatial thinking, through integration of geospatial technologies in classrooms teaching by designing appropriate lessons to utilize this technology for various subjects, such as science, history, geography, social science etc.. This would create spatial awareness and an understanding that all or most of today's problems have a significant spatial aspect to them, thereby creating a new generation of spatially literate students—who are conversant in spatial technology and solutions. It should emphasise on the following:

- Innovative Space School/ Summer schools/projects should be introduced such as NASA's Neo-Geography, Water rocket projects of JAXA, ESA's small satellite projects.

- Introduction of GI Kits at schools

- Promote GI as a Hobby

- Organise GI exhibition

- Introduce GI as a special paper

- GI in ITI/vocational training

5.2.3. Structured awareness/outreach programme for career professionals

- Promote open source tools and best practices for spreading the awareness on technology

- Internet based e-learning sites to be created and promoted. The role of distance education is another area of relevance. Distance education has been made popular by a number of online (distance) education courses and the same needs

to be replicated for GI.

- Government should play a key role and introduce Geospatial training in various Govt. Departments. The training can be organized in collaboration with industry/ academic institutes, with the help of customized courses, focussed on specific applications.

- Introduce GIS training in training institutes attached to various ministries for e.g. NPTI (Power), NITHE (Roads & Highways) etc..

- Include geospatial technology in the course curriculum of institutes where serving officers for refresher training like LBSNA, IGNFA etc. Showcase case studies of successful projects in various government departments, like forestry, PWD, land records, utilities etc.

- IAS and IFS probationers must have geospatial technology as a part of foundation course. Training should include projects requiring deployment of the technology in real-life problems, like property tax computation in municipal corporations etc.

- Proof of concept for large number of applications should be developed on open source software and placed on the web which can be freely downloadable.

4. NATIONAL CENTRE FOR GEOSPATIAL KNOWLEDGE ENGINEERING MANAGEMENT

INTRODUCTION

1. Geographical Information Systems (GIS) deals with technologies/ processes/software-hardware/applications related to data that can be characterized to a location or spatially or to a geographic coordinate. Geospatial technologies bring together information from multiple sources so that various types of development and what-if perspectives can be obtained for decision-making. In order to do this, the data is "tied" to a specific location on the Earth's surface and a coordinate system is used for this. Thus, layers of such data are generated for the same location coordinate and one can "see through" different data variables on a coordinate – enabling better correlative analysis and integration to GENERATE new information sets.

2. Applications of GIS, are strongly recognized to be socially relevant and are oriented towards supporting governance activities of government, preparing sustainable development strategies, enabling enterprises to better manage business processes and bringing geographical knowledge to citizens. Thus, GIS has considerable impact on the economies of local, regional, and national governments - by creating greater efficiency, more communication, and better decision making with the use of survey data, maps, images and geo-tagged tabular information.

3. Many developmental projects of the government have a major GIS element that is acting as a catalyst for the growth of geospatial industry. Corporate sector too is fuelling geospatial technology growth through enterprise GIS implementation in sectors like land management, natural resources management, environmental assessment, earth science, climate and weather, urban management, rural development, crop management, water resources management, power distribution, retail, infrastructure development, oil & gas exploration, telecom services and many other areas. India is also embarking on establishing a National GIS, which will have large ramifications of building a GIS Asset and positioning critical applications, critical for governance, enterprise and citizen services.

4. Geospatial technology is an emerging and important knowledge area and nations, that have developed capabilities in this area, would be enabled and better prepared for future activities of governance, securing their nations and also in the international arena. India also has to enable itself to be in the fore-front of this important technology and be part of a regime wherein Geospatial technology capability will determine its leadership and success, both within the country and outside in the global arena.

5. The importance of GIS in modern society is clear, with GIS now touching on all areas of society from the environment, to transportation, to government to enterprise and the general public. From scales of economies too, GIS offers tremendous opportunities. At the global level, the GIS industry is estimated to be about USD 2 billion in past years, with major share coming from GIS solution projects all over the world. Even in India, in the 11th Plan period, the government sector would be allocating/spending almost INR 5000 – 6000 crores on GIS activities over the five years in different projects of various central and state ministries.

6. Thus, Geospatial technology is today becoming a major capability-paradigm for nations to equip themselves with and be prepared for a fast changing world in terms of geo-location and geo-correlation. As India becomes more and more a well-knit entity in the global economy and global comity of nations, it is increasingly important that it positions geo-enabled capabilities that will help it, not only to address deepening societal demands but also articulate international positions and assessments, based on geospatial knowledge.

GEOSPATIAL TECHNOLOGY – OVER-ARCHING MANY DISCIPLINES

7. GIS technology has evolved over the past 40-50 years into a sophisticated discipline that inter-relates and encompasses surveying/navigation knowledge, map-making and cartography knowledge, imaging and image interpretation, geospatial database and computing/networking technology. Over the past few years, GIS has made tremendous progress. GIS is not just about images and maps BUT also of a whole host of SPATIAL data representation of tabular attributes - all of which comprises the geo-spatial content. When these spatial datasets are combined, a new paradigm of information regime gets created

bringing to fore new geographical relationships that enables visualizing spatial patterns in data, hitherto un-available, and bringing developmental perspectives right down to the grass-root level and also allowing for making better and qualified decisions. With the potential to construct and visualise maps, analyze information vis-à-vis its spatial attributes, create interactive queries and use results for easy decision-making, geospatial technologies are fast becoming the toolset of decision-makers, government, industry and citizens.

8. The diversity of geospatial technologies today is so wide that its over-arching ambit covers principles and fundamentals drawn from many disciplines:

    i. **Geographic Sciences** - the academic theory behind the development, use, and application of geographic information (GI) and addresses fundamental issues raised by the use of GI and related information technologies. Important concepts are Representation theory, Graph Theory, Topology, Geographic Information System (GIS), Spatial analysis, Spatial auto-correlation, Complete spatial randomness, Modifiable Areal Unit Problem, Cartography, Geovisualization, Spatial Decision-Support Systems, Cellular automaton and many other topics. All of these concepts/theories found many present and future developments of Geospatial technology.

    ii. **Surveying** – the technique and science of measuring and determining the two-dimensional or three-dimensional position of features of the Earth often used to prepare maps and boundaries of various features on the earth. Surveying requires knowledge of Earth and its geometrical and geophysical characters - Geodesy, geometry, trigonometry, mathematics, physics, engineering and also law. Surveying methods are based on ground-surveying (Theodolite, ETS GPS, ETS surveys etc); aerial surveying (imaging, Laser Terrain Mapping etc.); under-ground surveying (GPR, mining-surveys etc) and satellite measurements (imaging, radars, atmospheric chemistry measurements, ocean measurements etc.) – basically characterized by from where and how survey is done.

    iii. **Mapping and Cartography** – the techniques for realistically and aesthetically representing measured/surveyed data/features in a form that is easily understood and decipherable – generally on paper form (now

in database form   displayed). This requires knowledge of physics, trigonometry, mathematics, geographic science, graphics, communications, geodesy and map projections etc.. Cartographic concepts of map design, toponymy, generalization and   abstraction, symbology, projections/datum, visualisation etc play an important element in making this discipline very important in the geospatial domain.

iv. **Geodatabases** – the technique of efficiently organizing, maintaining, updating and archiving digital databases of maps/images and survey data so that access is easy, controlled and without information loss. The disciplines are of Mapping/Cartography, Geographic science, databases, computer science. Thus, concepts of map/image databases, granularity relationships, data standards, error modeling and accuracy estimation and clustering, in a time-spatial context is a very important area of research. Advances in spatial data mining and discovery will become more important as time-profile databases become prominent (over the years) and relevant.

v. **Geospatial Applications software** – the technique of software development in the geo-spatial domain, based on principles of surveyed data, cartographic geo-databases and needs of applications. These include geo-modelling of multi-parametric map/image data; geo-heuristics and geo-object modeling; software customization in geo-spatial domain and re-representation of dimensional data into simplistic forms of common understanding.   This requires knowledge of computing, software environment, geospatial developmental languages – basically coming from a background of strong computer science.

vi. **Geospatial Policy and Legal regimes** – the study of policy environment of geo-spatial technologies – in the commercial, public-good, security, inter- governmental regimes and addressing issues related to copyrights in GIS; Geo-IPRs; liability and international cooperation etc.. This is an emerging field and requires attention at the national level to prepare internally and lead at the international level.

INCREASING DEMAND FOR GIS IN INDIA

9.   Current and future government projects of development and governance, private sector projects of services provision and the citizens' needs of specific geospatial information would require a strong foundation of a knowledge-base and a strong skilled work-force than are available or will be trained through the current education system.

{Can we list here the possible major projects}

10.   The table below shows the GIS resource requirements for the Indian geospatial activity, including for National GIS, in the next five years.

Year	Survey/ Mapping expertise	Geo-database and GIS Apps expertise	Total GIS skilled- force requirement	Trained Users' development	University - level focus	School- Level awareness
2010	35,000	13,000	48,000	Large number in central and state govern-ment	A large number of University courses, leading to GIS de-grees and research	GIS aware-ness from 10-12 level
2011	42,000	15,000	57,000			
2012	50,000	17,000	67,000			
2013	58,000	20,000	78,000			
2014	67,000	22,750	89,750			
2015	77,000	26,000	1,03,000			

11.   Meeting the requirement of adequate workforce with the requisite skill set, however, is a great challenge for the geospatial sector. Geospatial education in India is still in a nascent stage and unless more educational institutes start offering degrees in this field, there will be a severe human resource crunch.

PRESENT SCENARIO OF GEOSPATIAL KNOWLEDGE MANAGEMENT

12 Presently, GIS knowledge and education in India is catered through the university and education systems that provide the capacity-building and HR development activities. Some of the positive elements of GIS education in India are through:

- Few Universities (like Anna University, Bharatidasam University, Symbiosis Institute, JNTU, Andhra University, Garhwal University etc. that offer graduate and post-graduate courses in GIS and RS). In total, these systems bring out about 200-300 scholars in geo-spatial technology.

- Specialised institutions (like IIRS, Dehradun, SOI Training Institute and so on) that offer specialized training and orientation programmes. These cater to in- service and on-the-job training on RS and GIS in specialised fields.

{Can we flesh this properly}

13. From a technological edge point of view, the Task Force feels that there are still major gaps that need to be bridged in the geospatial knowledge arena.

The table below shows an assessment of skill-gaps in various GIS activities:

GIS Sub-elements	Leadership	Managerial skill	Technical Skills	Consulting and Systems Analysis	Research/ Modeling
Survey/ Mapping	Low	Average	Very Good	Good	Low
Geo-database development	Low	Very Good	Very Good	Good	Average
GIS Applications & S/w development	Low	Average	Average	Good	Average
Solution architecturing/ deployment	Average	Average	Good	Average	Low

14. Many of the institutions face tremendous challenges in keeping pace with rapid advances in geospatial technology and also meeting the challenging needs of strategic nature of geospatial technology. Universities lack funds and are unable to update facilities and get modern tools and systems (hardware and software) and thus knowledge remains in old regimes and does not get enhanced with time. For example, there is hardly any university that addresses advanced concepts of Cloud GIS; Object oriented GIS; Geo-data Mining and warehousing; geo-search algorithms; Legal Issues of GIS and so on. Similarly, universities also lack facilities of modern- day GPS, LTM, laser processing software, 3d-GIS tools etc. Faculty-enrichment also lags behind as faculty themselves are not exposed to the advances, with regular orientation lacking.

15. Thus, this impacts the quality of education and knowledge generated and gets restricted to lower-end domain of labor-intensive activities – say, Surveying and Mapping. This is not a good scenario as it inhibits overall and all-round developments of knowledge in the wide variety of areas and has the limitation of India becoming a "labor-force" as against a "knowledge force" in geospatial technology.

16. As with any educational activity, GIS education too needs special attention from government to bring in the necessary policies, programmes, institutional frameworks and networks, career opportunity schemes etc so that India can generate a large pool of GIS expertise that can power many needs of the future.

NATIONAL INSTITUTE FOR GEOSPATIAL KNOWLEDGE ENGINEERING/ MANAGEMENT

17. From above, it can be seen that the broad gaps in the capacity in the GIS arena needs to be bridged and a focused and concerted plan would be called for.

- Build and Maintain leadership in geospatial technology that can steer and culminate into a vast knowledge pool in the country that would support success for governance and development and also build

technological edge and leadership in global arena in business and also international cooperation

- Develop deep technical excellence in geospatial technology and its founding disciplines – both in quality and quantity. Technical skills in GIS sw and applications development need enhancements. This is the knowledge area and requires ability of integrating multiple knowledge of surveying, maps, databases, computing and software development related to GIS

- Promote and encourage a geospatial university education network by positioning a consortium of institutions that take up common and updated syllabus/topics, education practices, faculty exchange etc by positioning and supporting graduate and post-graduate geospatial courses in universities and institutions

- Position a national infrastructure of geospatial resources – facilities, projects, faculty/experts etc that would be the base accessible to all institutions and generate a common "cloud" concept in geospatial education.

- High-end geospatial Research and Modelling requires major impetus. It is good research in GIS that can fuel knowledge activity and theoretical concepts, Modelling and computing have to be at the core of the knowledge initiative.

18. With considerable investments in GIS projects for development by government, there will be a quantum jump in manpower requirement at different levels - not only to meet huge local market needs but also to be a outsourcing hub to provide solutions and services worldwide. The manpower requirements can be categorized into three major categories:

- Knowledgeable and expert work-force required in present time-frame (now to say the next 2-3 years) to meet the emerging demand

- Creating a NextGen GIS cadre of professionals/researchers that can take on advanced and sophisticated GIS tasks (say in next 5-10 years) – not just for Indian market but also enhance the capacity provision for GIS projects from abroad.

- Create a core expert base of researchers and technologists that will

provide the strategic knowledge edge to the country in the global arena and also bring the culture of excellence within

19. The paradigm is to see how these future needs of GIS country can be met with human resources that are oriented to meet the requirements and also fuel newer technology elements for GIS activities. This National Task Force has addressed this issue in its entirety and brings to the fore the need for an institution of excellence and knowledge management as important strategic steps that can be implemented for furthering geospatial technology development and usage in the country.

20. It is time for India to have a dedicated institution of excellence in geospatial knowledge with the objective of promoting a wide and deep knowledge enterprise in GIS through teaching, research and networking within the Indian GIS knowledge community and to collaborate to drive Indian interests in geospatial technology and applications. **Considering the above, the National Task Force on Geospatial Education proposes the establishment of a National Geospatial Knowledge Centre.**

VISION

21. The vision of the Centre is to build and develop a national knowledge enterprise that breeds and promotes excellence in geospatial research, education, training and overall national capability in geospatial technology.

GOALS AND OBJECTIVES

22. The goals and objectives could be:

   • **Create a national Geospatial excellence and Knowledge base through advanced and front-ranking research and technology assimilation programmes:** The NCGRET will undertake funded-research and advanced studies in geospatial technology/applications – surveying (ground/aerial/advanced), Photo-grammetry, Mapping and Cartography, Remote Sensing, Geo-databases, Geo-web services, GIS Applications

etc. This research, technology assimilation, advanced studies would help the nation to generate and maintain the best of advanced knowledge base in geospatial technologies.

- **Establish a Geospatial Knowledge Network in GIS:** The NCGRET will provide cohesive and single-point knowledge leadership and expertise to academia – schools/colleges/universities, industries – consultancy/practice- definitions, government – research inputs/application assessments/standards and practices and HELP create a national knowledge base for the use of research-based strategies and practices for advanced technological development in the geospatial sector.

- **Building National Skills and Competencies in GIS:** The NCGRET will promote and encourage the competency development and skill development in GIS in the country by creating, providing, demonstrating and partnering with universities/schools by making accessible and available a basic competency base – consisting of expert faculty, best of GIS facilities, advanced inputs and networked user projects for practical skill development.

- **Develop/Establish, Maintain and make Accessible state-of-the-art Resources on GIS:** The NCGRET will establish, maintain expand access to exemplary research, educational and practical knowledge resource for students/faculty/institutions etc through a Geo-spatial Knowledge Repository (GKR) and enable a clearing-house - as a regionally distributed technology infrastructure to share Resources in GIS.

- **Faculty Development and Outreach:** The NCGRET will also provide associated universities/colleges/schools for specialised Faculty development and help geo-spatial educators and guide them in positioning new and advanced concepts amongst students. This should help increase/update/ upgrade geospatial technology knowledge and provide skills to enable teachers to effectively deliver geospatial technology courses or incorporate geospatial technology into existing courses/programs.

- **Student Engagement**: The NCGRET will undertake, encourage and support an increase in the number, diversity and quality of students participating in and completing geospatial technology and application courses and programs of study in under-graduate, post-graduate, doctoral and post-doctoral awards.

- **Geospatial Policy and Practices research and inputs**: A clear focused programme of NCGRET would be in geospatial policy and practice inputs – inputs to government, industry etc that will help the nation in a more coordinated way of positioning policy and international and multi-lateral cooperation impacted by geospatial technologies.

{Can we specify details of each in a table}

FOCUS

23. Six areas of focus:

- High-end and advanced research in geospatial technology disciplines (listed in 8 above) – creating excellence and knowledge value.

- Developing and maintaining a state-of-the-art education resource base – curricula, facilities, projects, faculty etc which can, on the one hand, undertake research and education and, on another, help university networking.

- Education Networking – create a common platform or consortium of universities for expanding and enhancing the graduate and post-graduate programmes.

- Conducting of specific and specialised advanced training and orientation programmes in geospatial technology and education – for government, private industry and for faculty training for universities.

- Consulting to government and creating assessments/evaluation and independent documents/reports related to geospatial technology.
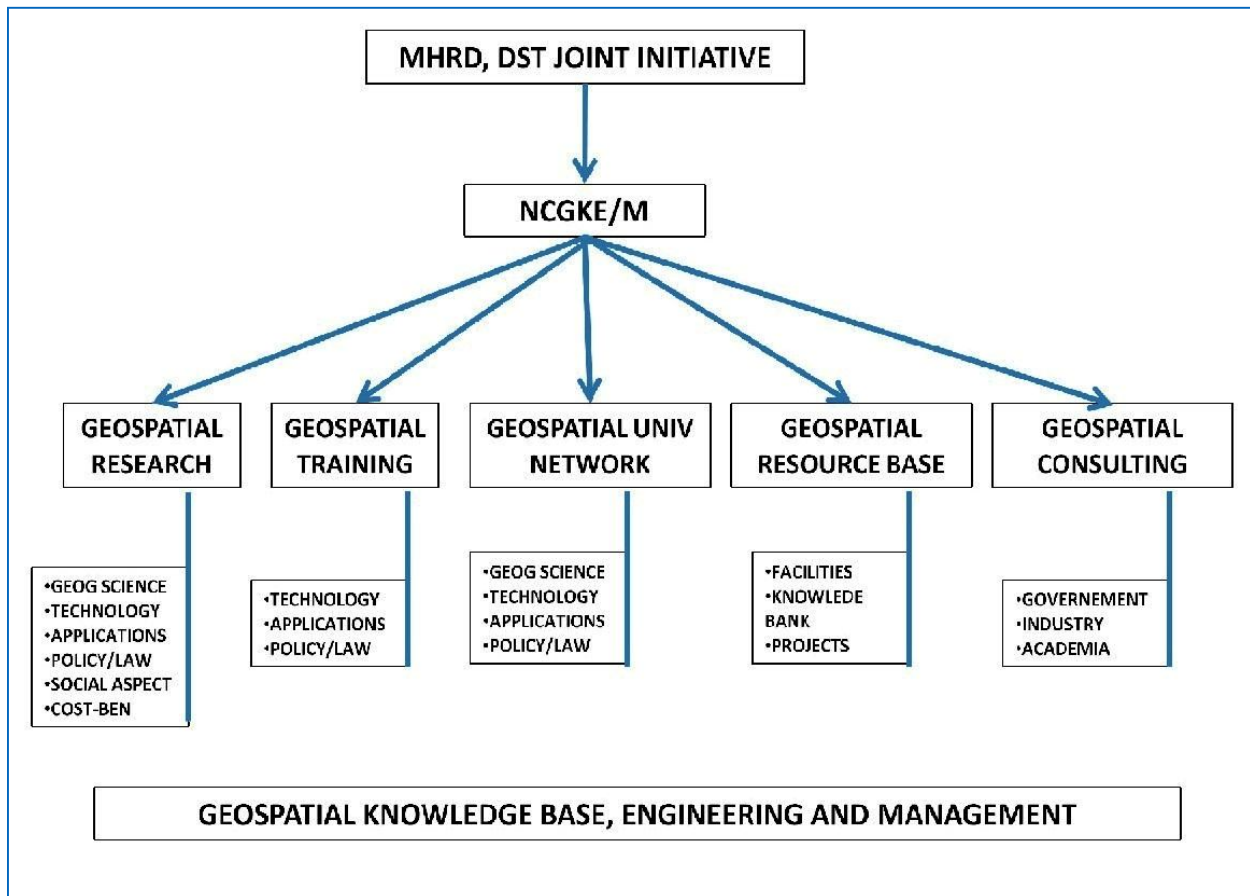
STRUCTURE

24. The Centre could be an autonomous institution with a Central University status and be a joint initiative of DST and MHRD and with the support of Planning Commission bring focus of best practices management and a national focus. It is important for MHRD to play a role in this as this will be a major effort on a new way of human resources development in geospatial technology that will benefit in positioning knowledgeable and skilled workforce for national requirements. DST can also play an important role as it has sufficient capability and resources in this area. Planning Commission must also extend its support in the light of the National GIS initiative that is being considered and also the future positioning.

25. Key experts with merit, knowledge and experience in geospatial technology could be inducted into this Centre from government or industry or academia and given the intellectual and professional flexibility to develop the geospatial technology knowledge base.

26. The Centre can be modeled on a R&D institution model and be agile and lean – BUT effective.

    {Can we make a structure diagram}

RELATIONSHIPS

27. The Centre can develop a matrix relationship with other entities:

    • Universities – as collaborators in furthering and enhancing geospatial education

    • Industry – for usage of resources

    • Government – for consulting, assessment and reports

    • International institutes – for leadership initiatives

BENEFITS

28. The major benefit will be that Indians will gain tremendous advantage in the geospatial knowledge arena and can best put to use the knowledge for national development. Further, India can also play a leading role in global arena and also enable policy positioning with best national interests.

29. Universities would get encouraged and support from the Centre that will enable its faculty to be enriched, use the facilities as required and also enable its scholars to access best experts/resources – thus enhancing the knowledge and professional qualities of the passing scholar.

30. With the Centre enhancing and vigorously pursuing Training, it should meet the increased demand for GIS orientation of government staff and also enable a wider understanding and use of GIS in governance and development.

31. Yet another major benefit would be that the level of geospatial literacy would be enhanced and be of high quality in the country – making professional knowledge available and flowing.

BROAD COSTS

32.   At a broad level, such a Centre would require about Rs 100-200 crores of funds and a recurring expense of ~ Rs 20-25 crores per year.

{General: Some more diagrams would be useful; Cost detailing would be useful; scheduling aspect would be useful}

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Minutes of the meeting taken by Dr. K. Kasturirangan, Member, Planning Commission, on the Taskforce meeting, on evolving Geospatial Education Strategy, held on 29.11.2010.

1. Dr. K. Kasturirangan, Member, Planning Commission, chaired the first meeting of the taskforce for evolving Geospatial Education Strategy on 29.11.2010. The list of the participants is at Annexure.

2. At the outset, Shri Amit Khare, Joint Secretary, MHRD welcomed the participants and broached the issue for discussion. Shri Khare out lined the background and scope of the Taskforce and emphasized on creating a national strategy for education and capacity-building in the field of Geospatial Technology, Shri Khare also said that the out put of the Taskforce would be immensely helpful for formulating the strategies for the 12th Five Year Plan for the Department of Higher Education.

3. Dr. K. Kasturirangan, Member, Planning Commission, Chairman of the Taskforce gave an overview on the bourgeoning geospatial industry and spelt out the relevance and utility of geospatial industry and remote sensing technologies being focused by various governments and private sector organizations. He also stated that the present HRD Minister has shown lot of interest for using this technology in the field of education. The Chairman explained in detail about the various geospatial centric programmes, initiated by the Central and State Governments. He advocated greater use of this technology, including PC- NNRMS, NRIS, NRDMS, NSDI, IMSD and so on.

4. Dr. K. Kasturirangan, Chairman, also referred to the efforts made by Indian Institute of Remote Sensing, Indian Institute of Surveying and Mapping, Anna University, Bhartidasan University and Symbiosis University for using geospatial Technology in the field of training, education and research programmes undertaken by them. The Chairman acknowledged the fact that geospatial industry is growing rapidly and becoming a part of mainstream industry. He further said that the national economy has recognized the potential of geospatial technology and all efforts are to be made to harness it to enable it to reach all walks of human life. He was of the view that a national Level policy should be evolved to attract students from the school level itself to take more interest in the subjects of geography and earth sciences as this will motivate them to be more responsible towards planet earth in their professional courses. He stressed the need for developing a comprehensive approach for

implementing geospatical education strategy right from the school level to college and University level, so as to serve the purpose of all stake holders including govt. and industry.

5. Dr. R. Siva Kumar, CEO of National Spatial Data Infrastructure (NSDI), Department of Science and Technology, detailed the programmes and activities being undertaken by Department of Science and Technology in this field. He elaborated the innovative approach of mapping the neighbourhood programme, wherein students of 20 schools in Almora district were provided with equipments, like PDA and GPS, and were given an opportunity to map the resources and infrastructure of their neighbourhood. The response and attraction of students for this programme was phenomenal and enabled them to develop much better understanding of their surroundings and resources. Dr. Siva Kumar also said that DST has constituted a committee on developing syllabus for geospatial course at school level and have supported establishment of Advanced Geospatial Technology Laboratory at IIT Mumbai. He further stressed that geospatial industry should be involved in training and education, both at formal and informal levels.

6. Prof. A. K. Gosain, Professor & Head of the Department of Civil Engineering, IIT Delhi, stressed the need of education at the manager level, wherein senior officials of both government and private sector, should be provided training on the utility of geospatial technology.

7. Shri Rajesh Mathur, Vice-Chairman, NIIT-GK Ltd., mentioned the issue of increasing need of skilled manpower. He further said that students, in general, are not very interested in taking up geospatial education at university level, although it had significant career potential for them.

8. Dr. Bharat Lohani, Assistant Professor at IIT Kanpur, while recognizing viewpoints of Shri Rajesh Mathur, said that there is a need to make geospatial education more attractive and increase the profile of this technology amongst educational institutions. Geospatial technology has a lot of potential for growth and more scientific research is required to be undertaken.

9. Prof. S. S. Mantha, Acting Chairman of All India Council for Technical Education, provided an overview of technical education programmes in various institutions. He said that courses in geospatial technology is available more as a specialization option and has not yet been fully recognized at the basic level. Major institutions are offering this course as elective and as part of other branches of engineering courses. Very few institutions have courses at the B. Tech. level for geospatial engineering. He further said that quality of geospatial education is also a concern as many colleges do not have adequate and competent faculty and infrastructure for the purpose.

10. Shri Kaushik Chakraborty, Managing Director of Leica Geosystems Geospatial Imaging India, specifically drew attention to school level GIS. He stressed the need of engaging with students for having more interest in geography and maps, in general, as it will facilitate a better understanding of human life among them. He cited few international examples and initiatives wherein students are involved in designing future cities and infrastructure as part of geography curriculum. This has resulted in generating a lot of awareness about GIS at the school level. He also cited instances to show that quite a significant number of students, who had undergone such exciting projects at school level, ultimately opted to pursue their careers in somewhat related engineering courses.

11. Dr. P. S. Roy, Dean of Indian Institute of Remote Sensing provided an overview of various institutions and colleges, offering courses in geospatial and related fields. He said a total of about 2000 students are produced every year from 36 universities and five IITs, while adding that this is very low as compared to the need. He also expressed serious concern with regard to the quality of education because of lack of qualified faculty.

12. The Chairman of Task Force requested Mr. Mukund Rao, Independent Consultant, and Mr. Sanjay Kumar, CEO of GIS Development to make a joint presentation. Both members submitted a background note, based on market survey and study being undertaken by GIS Development – a Geospatial Media company. Mr. Mukund Rao indicated that a total about 100,000 jobs are likely to be created in the next few years, with about 70,000 jobs for skilled workers and about 30,000 for

those having high-end engineering profile. He further said that the global geospatial industry market today is worth in the region of US$ 50 billion while the Indian market is estimated at nearly US$ 1 billion. But what is interesting is that Indian market is likely to grow more than double in the next five years, as both state and central government have outlined some large national development programmes having significant component requiring geospatial solutions. These programmes including NLRMP, APDRP, JNURM, NUIS, National GIS, put together, would imply more than Rs. 20,000 crores of investments by government of India. He further said that these programmes would be successful only if we have required trained and educated professionals, both in the government and industry.

13.   Shri Sanjay Kumar, Consultant GIS, suggested that there is a need for an independent full-time B. Tech. level course, run by premier institutions of the country, including few IITs, as there is a lack of highly skilled professionals in this field. National programmes and projects require highly qualified engineers to work out basic and fundamental architecture of the project and its successful implementation. He also stressed the need for a course that is able to integrate geography, computing and engineering. He further stressed the need to create a national-level institution, which could become a role model of geospatial technology while focussing on higher studies and research. This institution could be on the lines of IIITs and can attract students after school. He also emphasised the urgency for developing professional courses to enable the country to take advantage of prospects and opportunities offered by the growing global geospatial industry. In case we do not take immediate action, geospatial industry may fail to compete with other emerging centres like Philippines, Vietnam and so on, which will not augur well for the industry.

14.   Shri Amit Khare, Joint Secretary & Member Secretary, Task Force made the following suggestions for propagation of Geospatial Education:

⇒ Standardisation of certification

⇒ Setting up of an Institution for Geospatial Education

⇒ GIS learning to begin at the school level

⇒ International cooperation and attracting students from neighbouring countries

⇒ Involvement of state institutions for geospatial education.

15. While concluding, Dr. K. Kasturirangan, Chairman, directed the constitution of four sub-committees on following subjects to prepare a national strategy for geospatial education in the country and recommend implementation of geospatial education programme at desired levels; to identify and assess the overall requirements of human resources in the growing geospatial industry; to develop and design geospatial-oriented educational programme for technical and non-technical institutions; to provide overall guiding framework for development and implementation of National Geospatial Education strategy; to make recommendations on such matters that may be relevant for the implementation of national geospatial education strategy.

1. Geospatial Education at School level: Convener - Shri Kaushik Chakraborty, Managing Director, Leica Geosystems Geospatial Imaging India Private Limited

2. Geospatial Education at University Level: Convener - Prof. S. S. Mantha, Chairman, All India Council for Technical Education

3. Geospatial Awareness, Training and Outreach: Convener - Dr. P. S. Roy, Dean, Indian Institute of Remote Sensing and Director, UN Centre for Space, Science Technology and Education in Asia Pacific

4. Indian Institute of Geospatial Technology: Convener - Shri Amit Khare, Joint Secretary, Department of HE

The meeting ended with a Vote of Thanks to the chair.

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List of Participants

1. Dr. K. Kasturirangan, Member, Planning Commission – Chairman

2. Shri Amit Khare, Joint Secretary, Department of Higher Education

3. Shri G. S. Bothyal, Joint Secretary, Department of Higher Education

4. Dr. S. S. Mantha, Chairman, (Acting), AICTE

5. Dr. Bharat Lohani, Assistant Professor, IIT, Kanpur

6. Dr. R. Sivakumar, CEO, NSDI, Department of Science and Technology

7. Ms. N. A. Kazmi, Secretary, UGC

8. Shri R. M. Tripathi, Addl. S.G., Survey of India

9. Shri Kaushik Chakraborty, CEO, Leica Geosystems GI India Pvt. Ltd

10. Shri .A. K. Gosain, Professor & Head, Civil Engg. Department, IIT-Delhi

11. Shri Rajesh Mathur, Vice Chairman, NIIT GK Ltd.

12. Dr. P. S. Ray, Dean IIRS, (NRSC), Dehradun

13. Shri Sanjay Kumar, CEO, GIS Development, NOIDA

14. Shri Mukund Rao, GIS Consultant

Minutes of the 2nd Meeting of Task Force to discuss on Geospatial Education held on 13.1.2011 at Shastri Bhavan.

1. Dr. K. Kasturirangan, Member, Planning Commission, chaired the 2nd meeting of Task Force on Geospatial Education held on 13.1.2011. List of the participants is at Annexure.

2. Shri Amit Khare, Joint Secretary and Member Secretary, Task Force welcomed all the participants for attending the meeting. He introduced two members Shri N. K. Sinha, Additional Secretary (Technology Enabled Learning) and Prof. Ved Prakash, Vice Chairman, UGC with the Chairman, Task Force. Shri Khare briefly spelt out the constitution of four Sub-Committees in the last meeting held on 29.11.2010. He informed that two sub-groups have since prepared their papers and requested the remaining two groups to complete their assigned job latest by 24.01.2011.

3. In his opening remarks Dr. K. Kasturirangan, Chairman, emphasized the need to accelerate the job assigned to the four sub-groups to enable the Committee to present its Report to the HRD Minister as early as possible. The Chairman welcomed Shri N. K. Sinha, Additional Secretary and Prof. Ved Prakash, Vice-Chairman, UGC as they could not attend the first meeting. He advised that all the groups should prepare their respective reports so that the same could be circulated at least one week prior to holding the next meeting. He also suggested that a sub-group may be constituted for drafting and editing the final Report.

4. While observing that Geospatial Education is a vital area, Prof. Ved Prakash, Vice-Chairman, UGC, opined that an institution should be set up to promote and develop such education. He also stated that he had gone through the minutes of the last meeting and the line of action, as suggested by Shri Amit Khare appeared to be logical for moving forward in this direction. He stated that UGC is extending full support on the subject and a model curriculum would be framed and shared with all.

5. Shri N. K. Sinha, Additional Secretary (Technology Enabled Learning), stated that Geospatial Education would be helpful for developmental activities. Referring to Geospatial Education as a cutting edge proposition, he called for capturing it at all levels. He stated that in order to map our resources, we should harness this technology. Shri Amit Khare explained that the views expressed by Shri Sinha were already taken care of in the first meeting and separate sub-groups have been formed to develop strategies for Geospatial Education at School level, university level, and also for Outreach and Training.

6. Shri Kaushik Chakraborty, Convener of the sub-group Geospatial Education for Schools, made a power point presentation. In the presentation, the members of the group high lighted present status of geography education in Indian schools and details of the survey conducted by them to assess the application of GIS.

7. Shri Kaushik Chakraborty convener emphasized that all efforts should be made for making better programmes to understand the subject. He also felt that Geospatial Education should be used for mapping natural resources as well as for its protection. He shared his experience that many Geography teachers at school level do not have expertise of the subject and, in many schools, the teacher teaching geography is not even aware of that discipline. As a result, application of geography is not being done properly at the school level. He also underscored the need for activity-based learning.

8. Shri N. K. Sinha, Additional Secretary, suggested that a 20-hour module project/ curriculum may be prepared on geography. He also suggested designing computer games, that are geospatial centric and cover geographical points, which the children can play and, at the same time, learn about GIS.

9. Shri Ved Prakash, Vice-Chairman, UGC, emphasized that Geospatial Education need to be strategised to integrate if in the syllabus with social science and that NCERT could take a lead in this direction. He also suggested that a concept on this issue can be introduced at the +2 stage. He also suggested that this should be popularized at the school level and should be integrated with geography. Shri Sanjay Kumar apprised the Committee that they have integrated geospatial in one

of the ongoing experiments (Map your Neighbourhood) in Almora district and stated that the project has witnessed encouraging response.

10. Shri Rajesh Mathur, Vice-Chariman, NIIT, emphasized that a minimum learning level on geospatial could be inculcated in the curriculum of students and students should be taught the subject by assigning a project and on the basis of experiments. He suggested that Geospatial Education should be integrated with Mathematics, Physics and other subjects also.

11. Prof. S. S. Mantha, Acting Chairman, AICTE, was of the view that there is no dispute about integrating the subject of geospatial with the curriculum of school/ college-going students. According to him, the fundamental, concepts, learnt at the school level, will be useful later at a higher level.

12. Shri Mukund Rao, Member emphasized that geospatial education should be addressed through activities and need not be only curriculum based. He felt that students should have adequate knowledge of geography and issues related to geography by the time they are in XIIth Standard. A mix of activity and project studies could be undertaken. Shri R. M. Tripathi, Additional Surveyor General of India and Member of the Task Force, emphasized that focus on geospatial should be rural areas and it should not confine only to urban areas.

13. Chairman Dr. K. Kasturirangan expressed the need to build a mechanism to take geospatial education to school children as also general public so that the benefit of this can be reaped. The GIS awareness creation and training and other dimensions need to be spread to Govt. Officers, students as also general public. Some basic knowledge and attending some workshops could also upgrade knowledge. He, therefore, suggested that the recommendations of the proposed Committee should address Geospatial Educational at all levels along with a plan of action as to how to put in place a mechanism to accelerate this area.

14. Prof. Ved Prakash, Vice-Chairman, UGC gave details of educational institutions at university level where architecture and similar courses are taught. While emphasizing the need for GIS education at Higher Education level, he also suggested that the "Career Oriented Courses" could be taken up by students while pursuing their regular degree courses. He said that "Geospatial Education" could be introduced as a " Career Oriented Course".

15. UGC Vice-Chairman, Prof. Ved Prakash, also wanted most schools and colleges to introduce career-oriented programmes in GIS immediately. He further suggested

that credit based GIS could be linked with educational certificates like certificate course, diploma, advanced course, etc. He also suggested setting up of a Committee to examine as to how spatial education could be integrated in the existing system.

16.   Prof. Ved Prakash, also felt that there should be linkage to school education and social science should also be encompassed in the GIS. He, however, disagreed with the suggestion of setting up of stand-alone basis.

17.   Dr. Bharat Lohani, Associate Professor of IIT Kanpur, in his remarks observed that in India, we do not have any solid programme where fundamentals of GIS could be taught. It was also suggested that university should introduce professional courses ranging for duration of 3-4 years. He emphasized the need for commencing long term programmes in geospatial education by all universities including IITs, NITs, etc. He also advocated developing of a strong research base in Geospatial Education at the University level so that we do not become only "users' of technology rather we should become "Creators" or " Innovators"

18.   Shri Sanjay Kumar of GIS and member of the sub-committee on Indian Institute of Geospatial Technology, gave a presentation on the proposed institute. In his presentation, he informed that Geospatial education is being used by Government in its various programmes like NLRMP, APDRP, JNURM, NRDMS. He also informed that Survey of India, Geological Survey, Forest Survey etc. are using Geospatial Education. He also apprised the committee that banking, insurance, power, telecom sectors are using this technology. He felt that the proposed Institution should be set up under MHRD.

19.   Prof. S. S. Mantha, Acting Chairman, AICTE, stated that there is huge gap between number of pass-outs and the industry requirement. He, therefore, suggested that there should be linkage between industry and education and that geospatial education should be career oriented. Shri N. K. Sinha, Additional Secretary, emphasized that there should be maximum use information communication technology and fundamentals of this subject should be inculcated in the curriculum. Prof. Mantha also suggested that social science and engineering should be dovetailed into geospatial education. Prof. Ved Prakash, Vice-Chairman, UGC, suggested that all the Heads of Educational Institutions should ensure that Geospatial Education should not be neglected in teaching.

20.   Shri Rajesh C. Mathur, Vice-President NIIT, wanted to know as to how geospatial education could reach out to the common man. According to him, geospatial

education should reach educational institutions, professional institutions and public at large. He was of the view that GIS should be means to an end and that the common man should be aware of the importance of geospatial education. He also suggested that Department of Science and Technology and MHRD should come together and hammer out difficulties being encountered for the expansion of GIS. He also spoke of the need for a closer interaction of UGC/AICTE with industry to assess the demand-supply position as also to know what industry consumes, as the prerequisite for success.

21.   Dr. K. Kasturirangan, Chairman of the Task Force advised, all the Group Members to submit their papers well in advance so that the same could be examined and discussed threadbare. It will also help to incorporate valuable inputs received from the members during the discussion. It was also decided that members of the sub-group would submit their papers by 24th January, 2011 and a meeting of the conveners of the sub-groups will be held on 24th January at 11.00 a.m. in the chamber of Joint Secretary, HRD (Room 107-C) to compile and edit all the sub-group reports, before convening the final meeting of the Task Force.

22.   The meeting ended with a vote of thanks to the chair.

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List of Participants

1. Dr. K. Kasturirangan, Member, Planning Commission

2. Shri N. K. Sinha, Additional Secretary (TEL),

3. Prof. S. S. Mantha, Acting Chairman, All India Council for Technical Education (AICTE)

4. Prof. Ved Prakash, Vice-Chairman, UGC

5. Shri Mukund Rao, Chief GIS Consultant and Ex-President of GSDI

6. Shri Sanjay Kumar, Chief Executive Officer, GIS Development Pvt. Ltd.

7. Major General Dr. R. Sivakumar, Head, National Resource Data Management System (NRDMS), Deptt. of Science & Technology

8. Shri Kaushik Chakaraborty, Managing Director, Leica Geo-systems Geospatial Imaging Pvt. Ltd.

9. Dr. P. S. Roy, Associate Director (CB) NRSC, Indian Institute of Remote Sensi

10. Shri Rajesh. C. Mathur, Vice Chairman, NIIT

11. Shri R. M. Tripathi, Additional Surveyor General, Survey of India

12. Dr. Bharat Lohani, Associate Professor, Indian Institute of Technology, Kanpur.

13. Smt. Shefali Agrawal, IIRS, Dehradun.

14. Shri Amit Khare, Joint Secretary (EP)

15. Shri G. S. Bothyal, Joint Secretary

16. Dr. H. P. Samant, Associate Professor, St. Xavier's College, Mumbai.